Instruments THE MAGAZINE OF Measurement and Control

M. F. BEHAR, Editor

A Career for Women

IT is well-known that the percentage of women employed in the manufacture of instruments has been rising in recent years. It is generally believed that this proportion will rise still faster in coming years as America builds up an army of four million men. As yet, however, there are only a few women among professional users of instruments. (We do not refer to women scientists like Mme. Curie or to biological workers in hospitals, botanical laboratories, etc.) The province of *industrial* instrumentation is almost exclusively masculine. There is no compelling reason why it should remain so. It is an enormous province, made up of diversified fields. In particular, the use of industrial testing instruments is a field where women can render excellent services and find happy careers. From the General Electric Co. we have just received a photograph and a story bearing on this subject. The picture appears on the front cover; the story follows:

Mrs. ALICE ("Pat") O'HARA, spectrographic analyst in the works laboratory of the General Electric Company in Schenectady, N. Y., is a woman performing one of industry's most specialized tasks.

A mother and homemaker, Mrs. O'Hara also is one of the pioneer women in her profession, a field that is particularly important to the manufacturer and user of metallic products.

"Spectrographic analysis offers a broad opportunity for women with a knowledge of optics and a liking for research," said Mrs. O'Hara. She traces her own career to her high school days in Hillsdale, N. Y., a small town in the eastern part of the state near the Massachusetts border. The school was so small that it had no chemistry course but did offer instruction in physics, a subject in which Mrs. O'Hara became much interested. So when she went to the Albany State Teachers' College she majored in physics. Upon her graduation with a B.S. degree, she applied at the Schenectady works of General Electric for a job because, she says: "I did not think I would make a good teacher."

Her first job with the company was in the general engineering laboratory where for three years she investigated high-frequency power losses. During that period she was married and she left the company in 1926 to devote her time and energy to homemaking. A growing family brought increased expenses and in 1929 Mrs. O'Hara returned to work to supplement the family income. No jobs were available in her old department but there was an opening in the spectrographic analysis section.

At first she was concerned only with qualitative work. As she became more expert, more and more of her time was spent in quantitative analysis and now 50 percent of her work is in that field.

Which reminds us that Pittsburgh shares with Schenectady the honor of having an expert woman spectroscopist: at the University of Pittsburgh Dr. Mary Warga not only has done outstanding scientific work in that field but she teaches a course which is more industrial than purely scientific.

A Form of Sabotage

EDGERLY'S article (page 207) is suggestive in more ways than one. Several years ago, when manufacturers perfected the technique of completely piping and wiring control boards before shipment, we began to hear that in some localities some labor unions demanded that the work done at the factory should be undone and done over again by their own members. This seemed to us a crime against reason, efficiency and justice, but we were told at the time that there often was "another side to the story"—the wording of the equipment installation contract. There being no expert on labor laws and contracts on the staff of *Instruments*, this page refrained from discussing this waste of human effort. But now that America's life depends upon the efficient exertion of human effort, we consider it our duty to declare that there no longer are "two sides" to the control-board installation question. If a board is completed at the factory, it should not be torn apart and re-piped and rewired; and any organization forcing this to be done is aiding Hitler.

A New Department . . .

INSTRUMENT education and training courses, up to a couple of years ago, were mostly the subject of *preachments* by your editor, rather than of *reports*—because there were so few of them. The situation has changed with almost dramatic suddenness (see our May 1941 editorial, entitled "Bandwagon?"). Today there are so many courses that the reports, if printed end to end, would fill a whole issue of this magazine and would be so repetitive that nobody would read through the many pages. Simultaneously, the proportion to *Instruments* readers keenly interested in education has risen to such an extent as to justify starting a regular monthly department devoted to this field.

. . . and Its Conductor

BUT such a department could not be started haphazard. It was necessary to find someone fitted to run it: an engineering professor combining long experience, love of instrument work, prominence in the S.P.E.E., and various other qualifications. Fortunately, Mr. Richard Rimbach, President of The Instruments Publishing Company, has an old friend who meets these qualifications:

CARL F. KAYAN, Assistant Professor of Mechanical Engineering in the School of Engineering at Columbia University, has a background rich in experience and appreciation of the importance of teaching instrumentation to engineering students. He is a member of the A.S.M.E., A.S.R.E., S.P.E.E., and Sigma Xi, a contributor to numerous publications, and editor of Dr. C. E. Lucke's series of volumes on Engineering Heat Transfer.

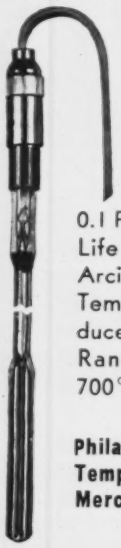
In the A.S.M.E., beside being a member of the committee on Industrial Instruments and Regulators, Professor Kayan serves on the standing committee on Papers of the Heat Transfer Division and heads its subcommittee on Heated and Cooled Enclosures. Further activities are chairmanship of the Air-Conditioning committee of the A.S.M.E. Process Industries Division, and member of the Refrigerator Test Code committee of the A.S.A. He has been a member of the Heat Transmission Committee of the National Research Council. His activity in the A.S.R.E. has included the chairmanship of the New York section.

In addition to the subject of Instrumentation, Professor Kayan's principal professional interests are thermodynamics and heat transfer, including their major applied fields of power, refrigeration and air conditioning. In these realms he has had extensive teaching experience of some fifteen years, coping at the same time with the practical problems.

Particularly in the field of Instrumentation as represented by measurement and control, he has been among the pioneers in this country in presenting the broad gage viewpoint. For the past seven years since he inaugurated the work in 1935, he has given a course at Columbia University under the title of "Indication and Control," the first engineering school instrumentation course to be announced in *Instruments*. This course was one of the first established in an American university for the study of industrial instruments and automatic control equipment, and was planned at Columbia for the needs of industry in this field jointly by Professor H. L. Parr and Professor Kayan. In this course Professor Kayan covers indicating and recording instruments and control equipment for pressure, temperature, fluid flow, liquid level, speed, etc. The treatment is on the horizontal basis cutting across the different engineering applications rather than on the basis of any vertical division or analysis, as would be represented by a single subject such as steam power or refrigeration, for example.

Watch for Professor Kayan's department in an early issue.

Philadelphia Merc-to-Merc Thermo-Regulators Feature



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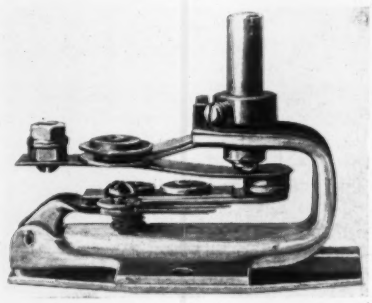
THE MONTH'S NEW INSTRUMENTS

In this department we strive to report each month ALL the new devices for measurement, inspection, testing, metering and automatic control.

When writing to manufacturers directly, please mention this department as your source of information. Or write to Information Section, Instruments Publishing Company.

Appliance Thermostat

New type of thermostat for electrically heated appliances, sold to appliance manufacturers under the trade name of "Positrol," employs no bimetal and depends upon



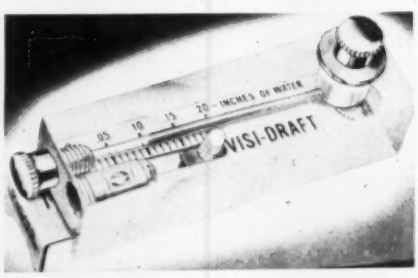
linear expansion of brass for its operation. Manufacturer claims it possesses many features and advantages not to be found in similar products using bimetal. — *General Thermostat Corp., 389 East 165th Street, New York City.*

Vibrometer

Announcement is made of an improved model of "Model 11" vibrometer (*Instruments*, Oct. 1940, page 292). Linearity now extends from 8 to 2500 c.p.s. (instead of 15-2500) as one result of refinements. Amplitudes from 0.00001" to 1" are indicated on the four-decade scale of a 9" instrument regardless of frequency or prod pressure. Maker announces a five-day trial and a one-year unconditional guarantee in connection with announcement of new model.—*Televiso Products, Inc., 2400 N. Sheffield Blvd., Chicago, Ill.*

Transparent Pocket Draft Gage

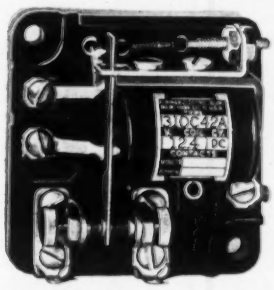
New "No. 181 Visi-Draft" inclined-tube type draft or differential gage is less than 4" long but is claimed to provide laboratory accuracy in the field by reason of provisions



for precise leveling and elimination of parallax errors. Level and zero adjustments are made simultaneously in a few seconds. Scale range is 0.05-0-0.20 inches of water in 0.01" divisions. Outfit includes an 8-ft. length of black rubber tubing, connectors, bottle of colored oil, oil dropper and directions.—*F. W. Dwyer Mfg. Co., 565 W. Washington Blvd., Chicago, Ill.*

Power Relay

"Model BK25" Sensitive Relay is said to have voltmeter accuracy from —24 to + 99° C. Molded base of Navy approved ma-



terial. Silver contacts. Operates on 0.001 watts. Claimed to deliver "perfect performance despite vibration or temperature changes."—*Kurman Electric Co., 241 Lafayette Street, New York City.*

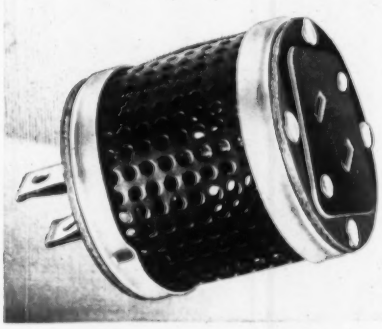
Electric Stopwatch

New "Minute Model" of "Time-It" electric stopwatch (see *Instruments*, March 1940, page 66) integrates to 1000 minutes

and reads to hundredths of a minute.—*Precision Scientific Co., 1750 N. Springfield Ave., Chicago, Ill.*

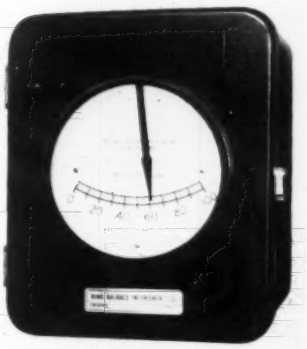
Line-voltage Regulator Giving Lightning Protection

A simple plug-in automatic line-voltage regulator inserted between power cord and electric outlet serves also as a lightning protection fuse in localities subject to severe electrical storms.—*Cavastat Mfg. Co., Inc., 285 North 6th St., Brooklyn, N. Y.*



Ring-balance Flowmeters

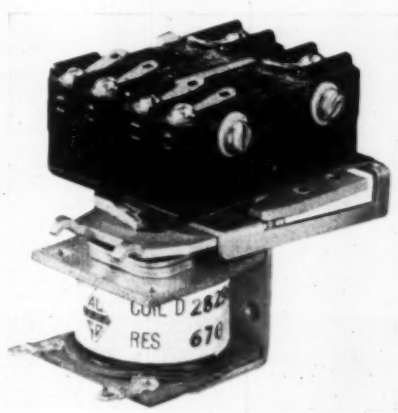
A new line of flowmeters for steam, gases and liquids is announced. All meters employ the ring-balance type of differential-measuring element which provides a linear rela-



tion between flow-rate and pointer (or pen-arm) deflection and, hence, uniform graduations of flow-rate scales. All meters are housed in welded steel dust- and moisture-proof cases. Case design is such that complete mechanism can be rotated in case, making all parts accessible for service or adjustment without removal. High-pressure models give full-scale readings on any differential between 20" and 150" of water; low-pressure models give full scale readings on any differential between 1" and 8" of water. All meters are supplied with calibrated check weights. Therefore, the range of any meter can be changed without taking the meter out of service. *Integrator* on all models has a 5-digit cyclometer register and a 6" checking dial permitting check of integrator without disturbing meter operation. *Indicating* models have a 9½" pointer traversing a 60° uniform-graduation scale. *Recording* models have 12" charts with uniform scales.—*Ring Balance Instrument Co., 740 N. Franklin St., Chicago, Ill.*

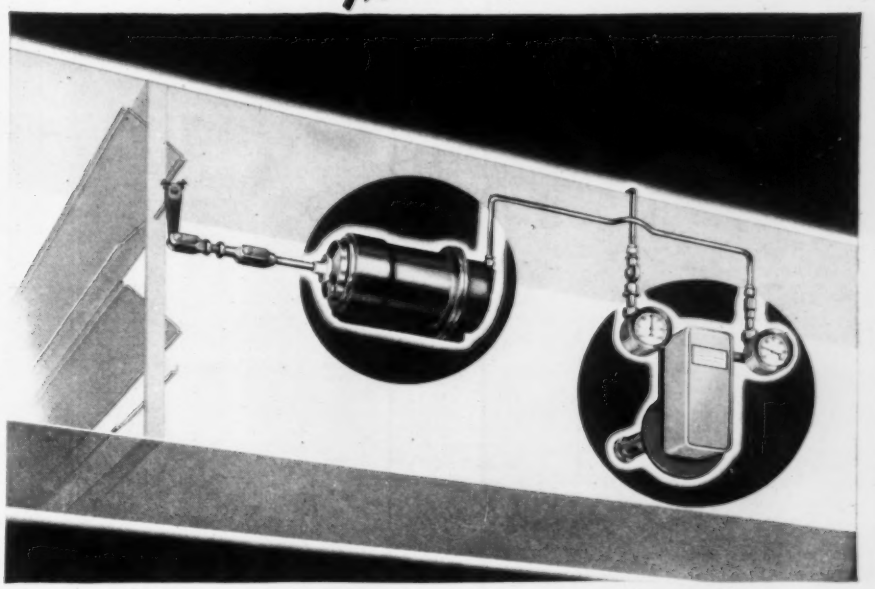
Vibration-proof Relay

New "Autelco Jr. Microswitch Relay" is said to meet demand for "an inexpensive relay having electrical contacts with larger current carrying capacity." This relay is



"sensitive," with "easy-acting" contacts designed for handling loads up to 10 amps (a.c. only—not suitable for d.c.), with small controlling currents. It is recommended for locations subject to sudden jarring, vibration, or tilting. Furnished with one or two microswitches, each with make, break or break-make contacts. Can also be supplied with one break-make microswitch and one break-make spring assembly with code No. 2, No. 4, or laminated silver contacts. Maximum operating voltage is 240 volts; d.c. or 50-60 cycle a.c.—*Automatic Electric Co., 1033 West Van Buren St., Chicago, Ill.*

JOHNSON *Long Travel* Damper Motors



COMMANDED BY JOHNSON *Jeweled Movement* THERMOSTATS

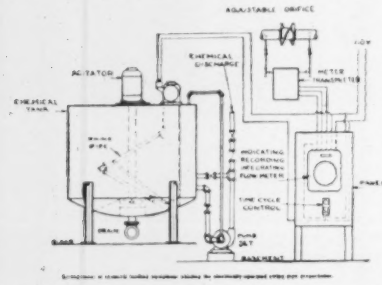
Johnson "Piston Type" Damper Motors are engineered specially for the particular job of controlling dampers G-R-A-D-U-A-L-L-Y. Emphatically, they are not just another valve operator adapted to other service. Designed from the viewpoint of dampers only, these Johnson "long-travel" motors improve the whole automatic control installation. Direct connection between motor and damper, without levers, means *more power!* Cylinder and piston arrangement provides *more movement* than is possible with conventional damper operators! When controlled by Johnson smooth-operating *Jeweled Movement* Thermostats, with adjustable sensitivity, the result is precise relationship between controlling instrument and controlled device. Accurate positioning of dampers under all conditions... Send for Bulletin D-251 which describes Johnson Piston Type Damper Motors or Bulletin D-261 which provides information on the Johnson Pilot Mechanism.

LOOK AT THE WHOLE SYSTEM
Efficient devices are valuable only if they function perfectly as part of the whole. Consequently, Johnson stresses the importance of complete control systems, designs, manufactures, installs, and services its own installations. A nation-wide organization stands ready to supply information on installing new or rehabilitating existing systems of automatic control. Ask for an estimate.
JOHNSON
Automatic TEMPERATURE AND AIR CONDITIONING Control

JOHNSON SERVICE COMPANY, MILWAUKEE, WIS. AND BRANCHES IN PRINCIPAL CITIES

Electrically Controlled Proportional Feeder

New electrically-operated chemical proportioner was developed particularly for proportioning a number of individual chemicals to water conditioning systems in accordance



with makeup requirements. In this combination a swing-pipe chemical proportioner is controlled from a Cochrane electric flowmeter provided with contacts on the integrator train. When the predetermined quantity of water has passed through the meter orifice, the integrator closes a contact in the electrical circuit, including a time-cycle relay. The later starts the proportioning motor, which lowers the draw-off pipe and then after a definite interval stops it. The duration is controlled from a panel-front knob for each chemical. Any number of chemical feeds can be controlled from one meter, but can be adjusted independently. In order to adapt this method of control to widely different loads, provision is made for varying the interval between charges and the duration of running the geared motor inversely one to the other. The geared motor (of heavy-duty construction) is of a type that is magnetically locked in position when current is off, thus preventing "drift." —*The Cochrane Corp., 17th St. & Allegheny Ave., Philadelphia, Pa.*

Shop Measurements Outfit

New "Scherr Comparitol - Inspectoset Unit" for shops engaged in production of parts close tolerances, is said to give any shop a virtual Bureau of Standards, since

it enables the shop to maintain complete control over all shop gages, mass produced parts, ball bearings, pins and other parts." Included in the unit is the "Comparitol" which is graduated to read to 1/10000" ± 0.002" and the "Ultra-Chex Inspectoset" consisting of 34 gage blocks which will make up all combinations in steps of 1/10000" from 0.300" to 8". The "Inspectoset" comes in a specially designed polished case to hold this and other gages. The Comparitol is first set with the Ultra- Chex in the Inspectoset, after which parts can be checked quickly and easily to 1/10000" by unskilled help, it is said.—*George Scherr Co., 128 Lafayette St., New York City.*

★ NEW! . . . . . DIRECT READING U-TYPE MANOMETER!

No adding liquid levels, no errors, no guesswork with direct-reading Trimount U - Type Manometers. Endless steel scale slides! Set zero at level in lowest leg, take reading at level in other leg! Accurate, foolproof, fast!

15" to 36" open type; 15" to 100" enclosed. For pressures to 700 lbs.

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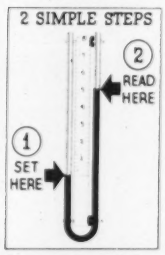

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Light Beams TO MICROAMPS

We could convert *sunlight* directly into *kilowatts*—but the cost is prohibitive!

There is nothing prohibitive about the cost of converting light beams into microamperes. Compare the performance and prices of our mounted and unmounted photocells before you settle your design and specifications for Photoelectric Cells.

Write Department I-3 for catalog giving technical characteristics.

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PHOTO ELECTRIC CELLS
BRADLEY LABORATORIES, INC.
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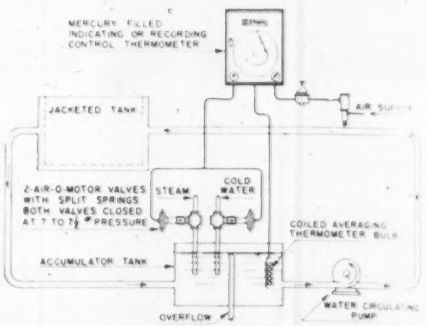
Temperature Control System for Plating Tanks, Etc.

New system of instrumentation for plating tanks (and similar applications) involves direct control of the temperature of the water circulated through pipe coils or



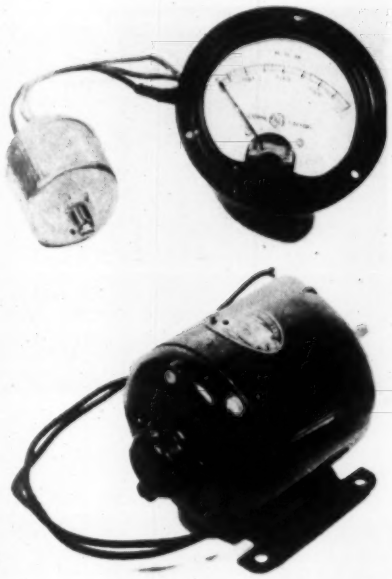
water jacket, rather than indirect control of the circulating water from the temperature of the plating solution. This basic method, states manufacturer, has been used for years where close control is essential in spite of high thermal capacities of main processing tanks. System has the following inherent characteristics: (1) Maintains a uniform plating temperature, to a few tenths of 1°F. (2) Saves steam and water by reason by closeness of temperature control. (3) Longer life obtained from the control thermometer because bulb is not subjected to destructive action of the plating solution. (4) Cheaper bulb construction suitable. (5) Not necessary to sacrifice space in plating tank for installation of bulb. (6) Not necessary to electrically insulate bulb and connecting tubing from sides of tank, hence no danger of bulb failures from electrolysis.—*The Brown Instrument Co., 4482 Wayne Ave., Philadelphia, Pa.*

Differential Pneumatic Telemetering System

Pneumatic telemetering system (see *Instruments*, Sept. 1937, pages 222, 242-3, 248) is available now with paired transmitters whereby differences in temperatures, flows, levels, pressures, etc. can be measured. New system consists of two measuring elements equipped with pneumatic transmitters, each of which delivers an air pressure proportional to the measured variable; and a differential pressure gage employing a mercury-filled U-tube and a float actuating a pointer or pen-arm. The two transmitters may be as much as 500 feet apart. Actual values of either or both of the measured variables may also be recorded on the chart of the differential pressure gage. Applications include controlling, and indicating or recording differences in: inlet and outlet temperature on feed water heaters, condensers, air preheaters, heat exchangers, etc.; inlet and outlet temperatures or superheater (thus giving the amount of superheat directly); inlet and outlet temperatures on economizers (thus giving heat recovery directly); inlet and outlet temperatures on bearing lubrication systems on turbines, rolling mills, etc.; wet- and dry-bulb temperatures (combined with the dry-bulb record) thus simplifying humidity calculations; flows from two tanks, etc.; levels in two remote tanks; outgoing and return flows in circulating systems; pressures in two remote pipe lines; pressures in two closely associated pipe lines where fluid from one line may not be permitted to enter the other.—*The Brown Instrument Co., 4482 Wayne Ave., Philadelphia, Pa.*

Electric Tachometer

For measuring the speed of cloth finishing and of many other processes, a new a-c. tachometer-generator equipment of the Alnico type consists of a small generator, a

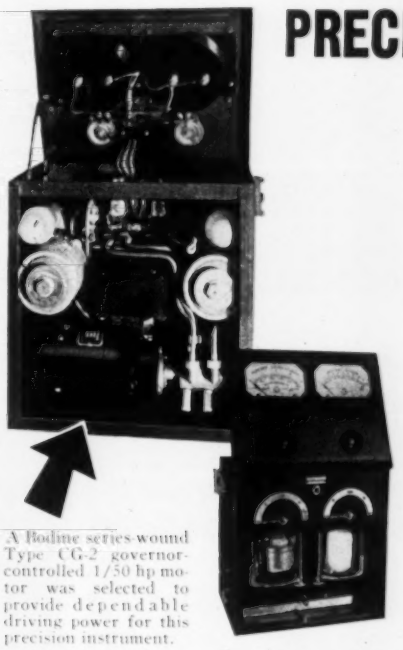


rectifier-type indicator, and an adjusting rheostat. The generator is of the single-phase, permanent-magnet type and can be coupled, geared, or belted to the machine or motor. It has an approximately linear speed-voltage curve from 500 to 3500 r.p.m. With suitable speed changes, the instrument will cover any speeds within a 7 to 1 speed range. The indicator is a standard G-E instrument and includes a single uniform scale. It can be calibrated with such special designations as r.p.m., f.p.m., or others to suit special requirements. The instrument reads for both directions of rotation, obviating the need of reversing switches.—*General Electric Co., Schenectady, N. Y.*

High-speed Coil Winding Counter

New "Clipper High-speed Coil Winding Counter" is designed for direct connection to the motor shaft or for operation through a flexible shaft. It can count at speeds as

high as 9000 turns per minute with motor wide open. Reset to zero is accomplished with a single motion. Pointer design gives instant visual check of reset; deducts turns taken off the coil in case of over-run, permitting accurate winding at high speed. Dial figures read to 10,000 turns. Pointers have specially designed friction hubs which provide maximal bearing area, hence minimal wear. Adjustable base provides for easy alignment with motor.—*Production Instrument Company, 702 W. Jackson Blvd., Chicago, Ill.*



A Bodine series wound Type CG-2 governor-controlled 1/50 hp motor was selected to provide dependable driving power for this precision instrument.

The Cities Service Heat Prover analyses exhaust gases from industrial furnaces, boilers, and Diesel engines and aids in determining operating efficiencies.

PRECISION GAS ANALYSER

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Governor-controlled Motor

The Cities Service Industrial Heat Prover is a precision analyser for determining the amount of free oxygen and unburned hydrocarbons in exhaust gases from Diesel engines, boilers, and industrial furnaces. Since the accuracy of the test depends upon the movement of the gas samples through the analyser, a Bodine governor-controlled motor was selected to drive the pump. Precision in speed control is thus assured under all test conditions.

Bodine motors are available to manufacturers of motor-driven machines and instruments in more than 3000 types and sizes. Motors with speed reducers, as small as 2⅜" by 2⅜" by 2 5/32", are listed for instrument applications where space is limited. Bulletins will be furnished on request.

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The RA-330 Sound Level Meter has all the features needed to meet your performance requirements.

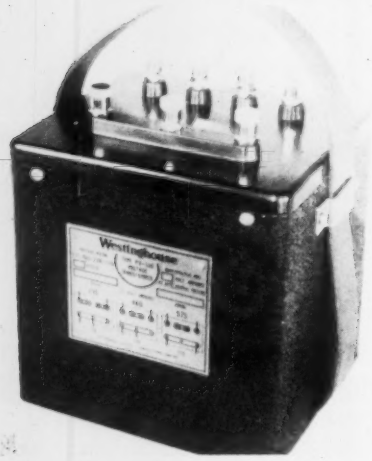
It features: 1. Moving coil microphone, 2. Feedback stablized amplifier, 3. Self-contained calibration check, 4. Simplified controls, 5. Compactness, 6. Economy.

Write for bulletin giving full details.

Electrical Research Products Inc.
76 Varick Street, New York, N Y.
A Subsidiary of
Western Electric Company

Potential Transformer

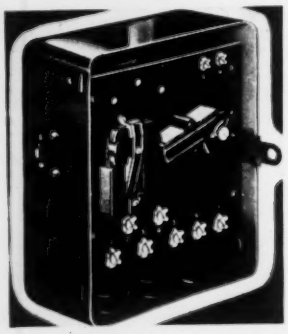
For use with portable indicating instruments and recorders, new PV-130 portable potential transformer is enclosed in an aluminum case. All terminals are of pol-



ished nickel to avoid any assumptions concerning their insulation. Terminal markings and polarities are clearly marked. Transformers are available for input voltages between 230 and 2300 volts with 115-volt output on 60-cycle lines. Accuracy is ± ¼% both on ratio and phase angle between 0 and 200% rated values. The accuracy and construction are such that the new transformers may be used on all portable and laboratory applications in delta connection, except for standards.—*Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.*

Summer-Winter System

Only three controls are required for positive year-around regulation of stoker and furnace fan operation on stoker-fired forced warm air systems, according to announce-



ment of new "Type 561SW" air conditioning stoker timer relay. This unit, in the winter, provides hold-fire operation of stoker as well as simultaneous fan and stoker operation at command of room thermostat. Fan or blower operation is unaffected during a hold-fire operating period. A summer-winter selector switch on the side of the control case can be switched to "summer" position: relay unit will provide summer fan operation for air circulation when house temperature goes above the setting of the same room thermostat. The only other controls required in the system, according to announcement, are the Type 870 internally heat actuated thermostat, which is a low voltage room thermostat, and a Type 515ATO4D combination fan, limit and relief fan control. Latter unit provides for all bonnet switch functions in one unit. Automatic day-night control for lowered night temperature may be included in the system by addition of Type 772 Tem-Clock, the announcement states.—*Penn Electric Switch Co., Goshen, Indiana.*

Speed - - -

DIRECT READING

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Centrifugal Type

Portable and Stationary
Indicating Speed and Total Run.
Flexible Shaft, Belt, or Electric
Drives for Remote Indicating.

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Types Available for Every Industry

Locomotives, Steam, Gas,
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Centrifuges, Textile Machinery
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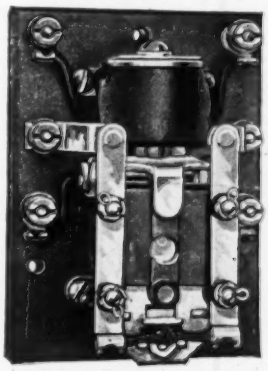
Write for FREE catalog showing largest available selection of Timers

JULES RACINE & COMPANY
20 WEST 47TH STREET, NEW YORK

Midget Latch-in Electrica Reset Relay

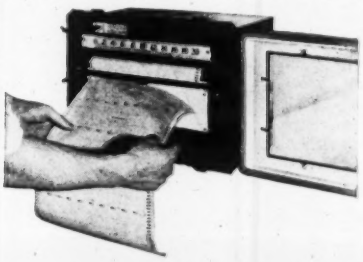
New midget-size mechanical latch-in, trical reset relay, "Type ABB-IN," mounted on a 3¼" × 2⅜" base, has a inductive load contact rating of 110

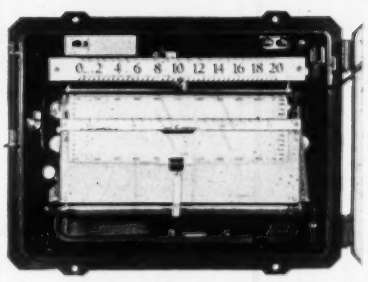


6 amps., or 220 volts 3 amps. a.c.; and 115 volts, 1 amp. d.c. Coils may be obtained as specified ranging from 6 to 220 volts a.c. at approx. 4 watts each; or 2 to 230 volts d.c. at approx. 2 watts each. A series resistor is used in the coil circuits when d-c. voltages above 90 volts are specified. New relay is available in practically any required contact arrangement and may be otherwise adapted to special requirements. It is said to be unexcelled when used in connection with 3-wire thermostat control. In addition to numerous other industrial uses, it is suitable for interlocking purposes on public utility equipment, etc.—*Struthers Dunn, Inc., 1315 Cherry St., Philadelphia, Pa.*

Daily or Batch Strip-chart Tear-off Feature

A new tear-off feature for maker's "Celectray" recorders and recorder-controllers consists of a tear-off bar and a re-roll with clip and tape. The clip, said to be of a

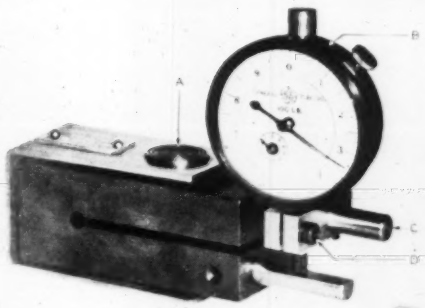




special design without springs, firmly grips the chart after a chart section has been removed. It is claimed that this feature is particularly useful for daily records as well as a complete record of any batch or run. These short chart strips can be easily filed for ready reference. Manufacturer points out that this feature provides a minimum of chart waste and when daily records are required a special chart can be furnished, with hour markings and with sufficient space to allow for resetting on correct time line.—*C. J. Tagliabue Mfg. Co., Park & Nostrand Aves., Brooklyn, N. Y.*

Electrode Pressure Gage

Primarily designed to measure the pressure between the electrodes of resistance-welding machines, a new direct-reading gage is for use either as a standard for

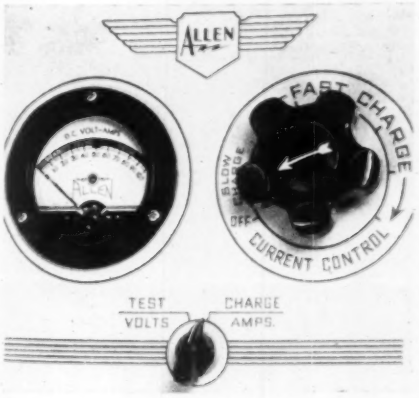


A—Electrode pads; B—Dial gage; C—Extension supporting rod; D—Lock screw for dial position.

checking existing gages or pressure indicators on spot, line, or projection welders, or for checking the electrode pressure at the time of set-up, before proceeding with production work. It may be used also by testing laboratories for force determinations, for checking various kinds of springs, etc. The new gage measures forces from 0 to 4500 lbs.; an automatic stop safeguards it against damage, should forces of more than 4500 lbs. be applied. Consisting simply of a calibrated steel yoke and a micrometer dial indicator, the gage is easily applicable to welding machines. When electrode pressures are to be measured preliminary to production work, the gage is inserted between the electrodes so that they press on the pads on the top and bottom of the yoke. The electrode pressure is adjusted until the desired pressure is registered on the dial. The gage is then withdrawn and the welding machine placed in operation. The dial indicator is direct reading: no calibration curves or multipliers are necessary. It has two scales, one for reading in 10-lb. intervals up to 1000 lbs.; the other to read in 1000-lb. intervals. Each gage is calibrated at the factory before shipment.—*General Electric Co., Schenectady, N. Y.*

Auto Battery Chargers

Both "in-the-car" charging, and "one-minute" testing are possible with the new "Allen Fast '50' Chargers." Charging is accomplished without removing the battery



cables. Leads permit charging a battery during a lubrication, wash job, etc. The voltammeter is calibrated for both charging and testing. For the latter three colored zones are marked "Dead", "Recharge", and "Charged" for load tests (starter turning engine). Manufacturer states that approximately 45 minutes are saved each time a battery is charged in the car with the "Fast 50."—*Allen Electric & Equipment Co., Kalamazoo, Mich.*

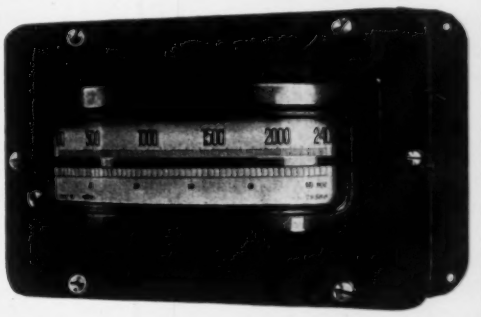
WHAT do you need in a PYROMETER ?

SENSITIVITY RESISTANCE
DURABILITY SIMPLICITY

Engelhard Direct Deflection Indicators have all these features . . . Accurate sensitivity to the most minute voltage variations due to suspension type construction . . . High resistance per millivolt and no appreciable error when used with thermocouples of different resistances and on connecting leads of considerable length . . . Sturdy construction, adapted to use under severe conditions without danger . . . So simple that instant readings may be made directly in either millivolts or temperatures by someone unfamiliar with the principles of pyrometry . . . On kilns or furnace installations, where "spot readings" are desirable—the Engelhard Rotary Switch permits separate readings from many points.

Write for Catalog

PORTABLE MODEL P-1

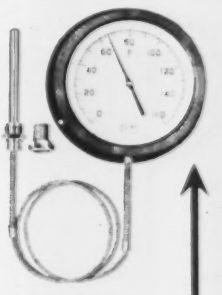


WALL TYPE W-1

CHARLES ENGELHARD, INCORPORATED
90 CHESTNUT ST. NEWARK, NEW JERSEY

MERCURY DIAL THERMOMETERS

1—VERY SENSITIVE
2—EXTREMELY ACCURATE
3—STURDY BUILT
4—EASY TO READ
5—ALL RANGES



Palmer Dial Thermometer Installations have proven to be very satisfactory because of their accuracy and sturdy construction. Stainless-steel flexible tubing connection and bulb are standard without extra charge. Furnished with plain bulb, union connection, separable-socket and flange connection. Ranges: —40 +1000° F. (or 550° C.). Built by craftsmen who know how to make good thermometers. (Write for Bulletin No. 1500.)

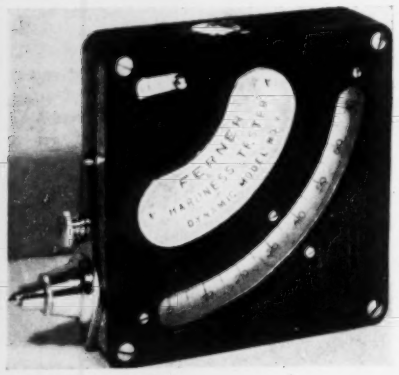
THE PALMER CO. Mfrs.

THERMOMETER: Recording, Industrial, Laboratory and Dial

2511 NORWOOD AVE., CINCINNATI, NORWOOD, OHIO
Canadian Plant: King & George Sts., Toronto

Dynamic Hardness Tester

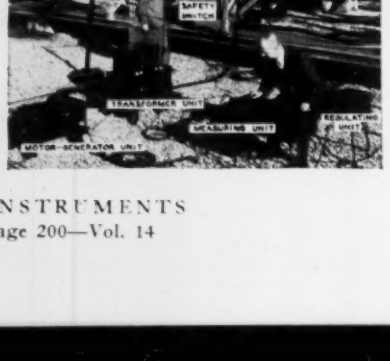
Revision of general design, altering the detail construction and radical innovations have resulted, it is said in a device that may rightly be called a new instrument.



However, "Dynamic Tester No. 7" has been long in development, so that none of its features is experimental, it is said. New Tester weights 13 oz., measures about 4" × 4" × 1¼", operates on the principle of the falling pendulum hammer activating an arrow wire sliding over an arc scale so as to register the maximum heighth of rebound from impacts upon the specimen. Circular levels on two edges of the instrument case enable the operator to position the instrument so as to prevent friction or unreckoned loading element which might alter free rebound. The point from which the pendulum hammer falls, which can be varied at will, adjusts the weight of the blow to a standard which has been pre-selected for comparative tests. Resultant wide range of loading permits hardness tests on materials hitherto outside studies with commercial hardness instruments. Maximum load, when carriage holder is located at 70 on the scale, is 0.033 lbs. "Universal Attachment" permits hardness tests to be made on uneven, or irregular surfaces, sides of gear teeth, sections close to cutting edges of dies, punches and contouring tools, etc. This auxiliary device, fitting all regular models of the instrument, carries four "striking pins" with shaped ends enabling the operator to test definite spots, study thin, hollow, curved or bevelled surfaces of metal parts. New tester is self-contained, conveniently carried in one's pocket and requires no skill. Test values being clearly visible, the "human element" is eliminated.—*R. Y. Ferner Co., 131 State St., Boston, Mass.*

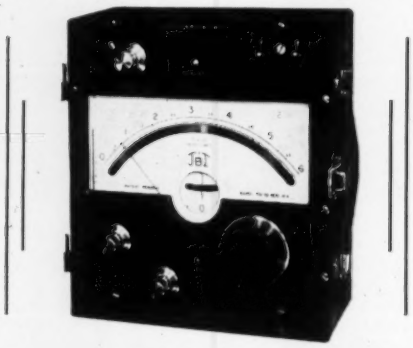
Bushing Test Set

Service interruptions due to failures of bushings, insulators and other high-voltage equipment are minimized when periodic tests are made with a new portable test set expressly designed for field tests of installed bushings and insulators. New set is useful also for measuring the dielectric characteristics of small cable lengths, oils, compounds and other dielectrics. New set is free, even in 220-kv. switchyards, from the effects of e-s & e-s, stray fields emanating from power circuits. This immunity results from the use of a detector which responds to a frequency of 70 cycles but not to the standard 60. The odd 70-cycle frequency is supplied by a portable motor-generator set, and because of the difference between test and power frequencies, it is unnecessary to take direct and reversed readings and then average the results to avoid stray field effects. Scales read directly in power factor and capacitance, and at the normal test voltage of 10,000 volts no correction factors need be applied to the readings. Two high-voltage transformers provide potential for tests at a normal test voltage of 10,000 volts. This voltage can be reduced as low as 1250 volts by a regulating unit. Step-up transformer and motor of motor-generator set operate on 115 volts, 60 cycles. Any test man can quickly learn to use new set, it is said. Ground shields protect test man from high-voltage during tests. If break in ground connection to shield occurs the high-voltage transformers are deënergized.—*Leeds & Northrup Co., 4970 Stenton Ave., Philadelphia, Pa.*



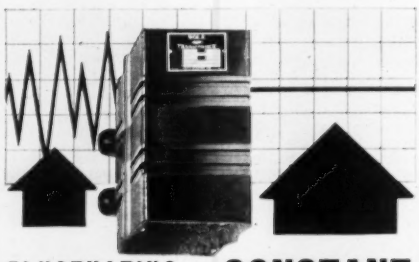
See Temperatures AS They Change

● Does the possibility of changing resistance in thermocouples and leads justify a potentiometer-pyrometer for your experiments, production, field tests, or instrument checking? Then use Model 70-PO (portable type illustrated). You watch even minor temperature changes at the instant they are indicated—with little or no balancing, and no standard cell. Write for Bulletin 540-70-PO.



For other uses, J-B-T millivoltmeter pyrometers provide instant, continuous, easy-to-see facts. These instruments are fully compensated and come in many sizes and styles. The values are exceptional, deliveries surprisingly prompt. In requesting quotations, please mention your application.

J-B-T INSTRUMENTS, INC.
441-I CHAPEL ST. NEW HAVEN, CONN., U.S.A.



FLUCTUATING LINE VOLTAGE **CONSTANT VOLTAGE**

Whether it's 1 VA for an instrument or 10 KVA for a Production line—here's constant, stable voltage for you at all times, even though the line voltage varies *as much as thirty percent.*

They are fully automatic and instantaneous in operation—have no moving parts—require no maintenance—and are self-protecting against short circuit.

You can build a SOLA CONSTANT VOLTAGE TRANSFORMER into your product, or incorporate it in your production line or laboratory and know that every test will be made under identical line conditions.

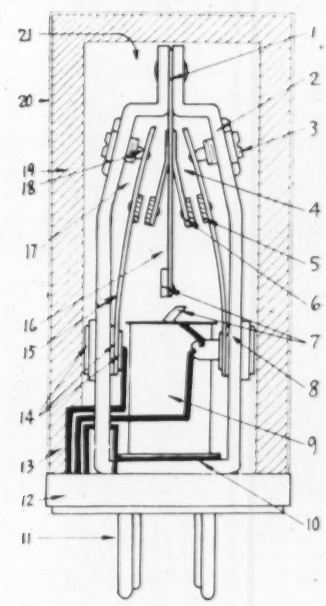
Compact—economical. Standard designs are available, or units can be built to your special specifications. *Ask for* **Bulletin GCV-74**

SOLA ELECTRIC COMPANY
2525 Clybourn Ave. Chicago, Ill.

SOLA
Constant Voltage
TRANSFORMERS

"Push Pull" Vibrators

New vibrators do not depend on elasticity of steel but employ magnetic flux to push, then pull, the reed and its contacts. Piling and chattering are thus eliminated and r-f hash minimized. Illustration shows principal features: (1) Stack assembly eliminated. (2) Continuous metal frame gives dual magnetic path. (3) Micro adjustment of contact points at factory. (4) Stationary bronze small arm riveted to reed in angular position to facilitate wiping action. (5) Pure tungsten contacts. (6) Reed contacts riveted to small arm. (7) High magnetic saturation Armco iron. (8) Parts cadmium-plated. (9) Second winding of coil reverses polarity of pole piece, giving the exclusive push-pull feature. (10) Magnet and driving coil give twice magnetic flux of ordinary units. (16) Swedish steel reed, shaped to eliminate breakage, mounted in natural pendulum position. (17) Side arm slotted to cushion reed action, reduce mechanical noise, facilitate wiping action and prevent piling. (18) Ceramic insulating tips. (19) Container insulation being sulphur-free rubber, no fumes can be generated to corrode contact points. (21) Center of gravity is in center of construction. Under vibration-contact points are not robbed of full impact.—*The Turner Company, 800 17th St., Cedar Rapids, Iowa*



PORTABLE
WHEATSTONE BRIDGE

A high grade instrument for measuring resistances from a fraction of an ohm to 10 megohms. Contains a 4-dial rheostat, ratio dial, galvanometer and battery, all enclosed in a substantial walnut case. Nine coils per dial. Accuracy .1%. Built to endure.

Cat. No. 1050—Portable Wheatstone Bridge with Murray and Varley Loops...$110.00

Cat. No. 1052—Portable Wheatstone Bridge without Murray and Varley Loops.$90.00

Send for Bulletin No. 105

RUBICON COMPANY

Electrical Instrument Makers

Ridge Ave. at 35th St. Philadelphia, Pa.

SAND—SYMBOL OF OPTICAL INDEPENDENCE

BY itself, only a handful of sand—fine, pure, white crystals of quartz from a Pennsylvania hillside. But, blended with boron, sodium, barium, lead, phosphorus and other elements—it becomes optical glass, one of the basic indispensable materials of national defense—and of modern civilization.

Thirty years ago America was wholly dependent on Europe for a supply of glass for optical instruments. By 1918, glass to fill the vital needs of optical manufacturing in the United States was pouring from the B&L glass plant.

Today, for binoculars and fire control equipment that are the eyes of the Army and Navy—for metallographic and spectrographic equipment that are the eyes of industrial research—for microscopes that are the eyes of all science—for spectacle lenses that are the eyes of the nation's citizens—America is completely independent of foreign supply.

BAUSCH & LOMB

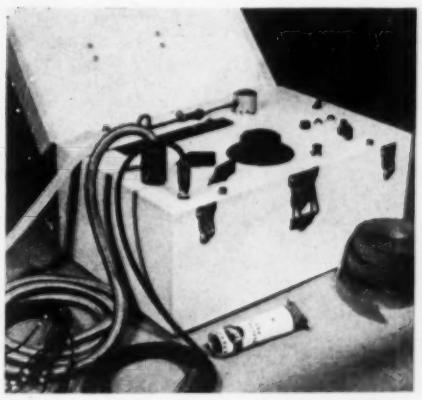
OPTICAL CO. • ROCHESTER, NEW YORK

ESTABLISHED 1853

An American Scientific Institution Producing Optical Glass and Instruments for National Defense, Education, Research, Industry and Eyesight Correction.

Electroencephalograph

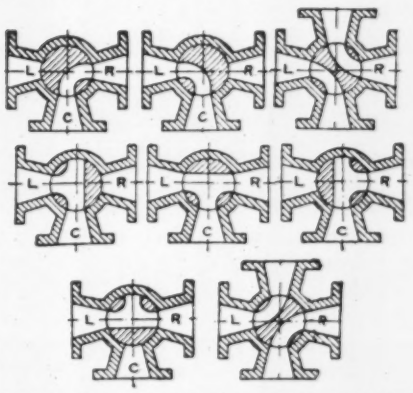
New "Junior Garceau Electroencephalograph" is an extremely sensitive (μv.) instrument for amplifying and recording potentials generated by the brain. These are



led off from electrodes placed on the scalp or from leads in contact with the exposed cortex. Operating from 115-volt 60-cycle power line, it is the first instrument of this type which requires no shielding cage to screen the subject from interfering electromagnetic fields, which are removed by a special interference-eliminating circuit. Recording on a prepared dry tape by electrochemical means produces an instantly visible permanent record requiring no processing or developing. Overall sensitivity of the system is 0.5 mm. per microvolt. Inherent noise level from all sources is less than a microvolt. Overall response is linear within 2 decibels for frequency and amplitude. Speed of the recording tape is constant at 3 cm. per second. The entire equipment is contained in one portable case 18" × 12" × 9", weighing 58 lbs. Applications of this new instrument in neurology include diagnosis of epilepsy, localization of cerebral lesions such as brain tumor, and diagnosis and study of schizophrenia. Of particular value is its use in the detection of epileptic tendency in aviation personnel. The *recording oscillograph* which forms part of equipment is an entirely original design, which is expected to find many industrial applications. — *Electro-Medical Laboratory Inc., Hollis ton, Mass., U.S.A.*

Multiport Valves

Various port and stop arrangements are provided by new "Multiport Valves." It is said that one valve can do the work of two, three or four ordinary valves, according to



the arrangement of flow-ways and ports and degrees of turn. Sizes range from ½" to 16", for pressures tested to 3000 lbs. For high temperature services and where extremely corrosive or erosive line contents are handled, the Multiport type may be furnished with Merchrome coating. — *Merco Nordstrom Valve Co., 400 Lexington Ave., Pittsburgh, Pa.*

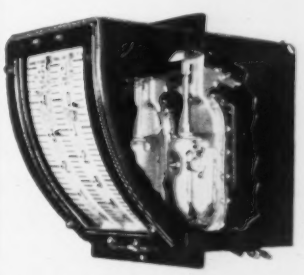
BAILEY METERS

METERS and CONTROL *for Boiler Room Service . . .*

Boiler Meters Reduce fuel costs, lessen maintenance and outage, lower standby costs, and add capacity. They indicate, record and integrate Steam Flow from the boiler, record Air Flow supplied for combustion and record Flue Gas Temperature.

Bailey Boiler Meter

Multi-Pointer Gages for indicating drafts, pressures, differentials are available with any number of pointers from one to twelve. They are actuated by sturdy yet sensitive diaphragm units.



Multi-Pointer Gage

Flow Meters. For indicating, recording and integrating the flow of steam, feed water, compressed air and other fluids.

Coal Meter

Granular Material Meters For accurately measuring the flow of coal or other granular materials in gravity chutes from overhead bunkers. The total quantity of granular material is shown on a large illuminated counter which may be easily read at a distance of 50 feet.

Control Systems Make possible the everyday operation of equipment for steam generation and utilization at test efficiencies. They are applied to the control of combustion, feed water, superheat, desuperheat and other factors.

Complete Information on any of the above Bailey products will be gladly furnished upon request.

G-14

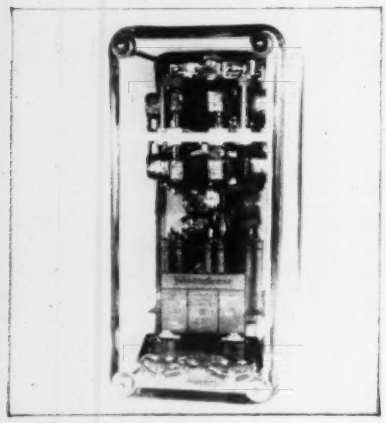
BAILEY METER • COMPANY •

1041 Ivanhoe Rd., Cleveland, Ohio

BAILEY METER COMPANY LTD., MONTREAL

High-speed Directional Relay

New Types H-3 and HV-3 relays are for use in directional discrimination in the detection of phase and ground faults. Although generally installed along with



fault detector relays, these high-speed three-phase directional relays are also used with frequency relays to trip tie line breakers on under or over frequency. Glass cover permits complete visual inspection without removal. A similar construction with plug-in features can be supplied. Directional element consists of three electromagnets and three loops around a vertical shaft. On the outer legs of each magnet are two voltage coils: applied voltage is said to induce a "large" current in the loop by transformer action. The current coil is on the center leg of the electromagnet; applied current produces an air gap flux. This flux interacts with the loop current and causes rotation of the shaft in a direction corresponding to the instantaneous direction of power flow. The voltage restraint element is similar to the directional element except that no current coil is used. In case of a system fault which collapses or brings in phase any of the applied delta voltages of the three-phase system, the voltage restraint is removed. Double-throw silver contacts permit application to either single line or parallel line protection. The contacts will close 30 amperes at 250 volts d.c. and the auxiliary relay (contactor switch) will safely carry this current long enough to trip the breaker.—*Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.*

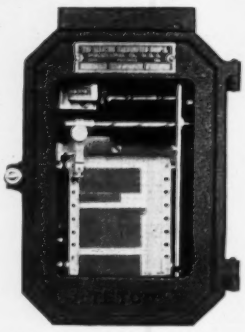
Electronic View-finder for Television Camera

Replacing the usual optical finder and peep-hole focusing technique, an electronic view-finder, reproducing precisely what is actually being picked up in television terms,

mounts on the side of maker's Iconoscope camera. A high-intensity 5" cathode-ray tube (supplied with either green or white screen) provides a fine focused brilliant image. Brightness, focus, video gain, horizontal size and vertical size controls are arranged around the tube face, for convenient manipulation by the cameraman. The electronic view finder reproduces the video image as picked up by the camera lens and iconoscope, and as translated into television terms, thereby serving at once as a view finder and focusing means and even an image monitor at the camera. The electronic view finder connects with its own power-supply unit by means of a 12-conductor cable that plugs into a 12-prong receptacle. All voltages necessary for its operation are supplied by the accompanying power-supply unit which also preamplifies the video signal and supplies it to the finder unit through coaxial cable. The supply unit in turn receives the video signal from the camera.—*Allen B. DuMont Labs., Inc., 2 Main Ave., Passaic, N. J.*

TETCO

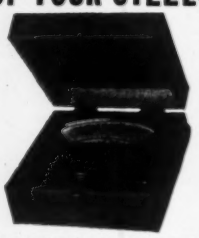
Speed Recorder



Creates a permanent time record on a waxed chart. Accurately records rate of production, time and duration of stops, total quantity produced.

The Electric Tachometer Corp.
1358 Spring Garden St., Philadelphia, Pa.

TEST MAGNETIC PROPERTIES OF YOUR STEELS



THE ONLY SINGLE BUTTON ELECTRICAL RETURN FLUXMETER
SIMPLEST AND MOST EFFICIENT
Bulletin 504
THREE DIFFERENT STYLES

Portable Standard with single electrical zero return.
Switchboard Type with above zero feature located on flexible lead for bench operation.
Two Button Pointer Shift in place of our patented standard zero return at a lesser cost.

Acknowledged leaders in development of high sensitivity meters

RAWSON ELECTRICAL INSTRUMENT COMPANY
110 POTTER ST. CAMBRIDGE, MASS.
Branch: 15 East 26th St., New York City
Representative: E. N. Webber
4358 W. Roosevelt Rd., Chicago, Ill.

Vacuum - - - Thermocouples

featuring

DEPENDABLE STABILITY
HIGHER OVERLOAD
FASTER RESPONSE

Our thermocouples will meet the most rigid requirements. Write your requirements to—

American Electrical Sales Co., Inc.
67 E. 8th ST. NEW YORK, N. Y.

★ *NATIONAL* ★

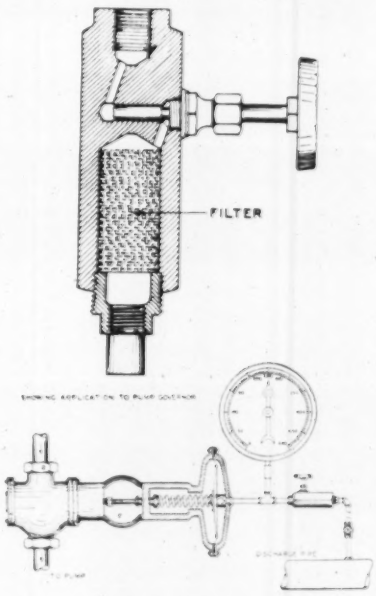
RHEOSTATS

Ask for Catalog No. 5

National Electric Controller Co.
5305 Ravenswood Ave., Chicago, Ill.

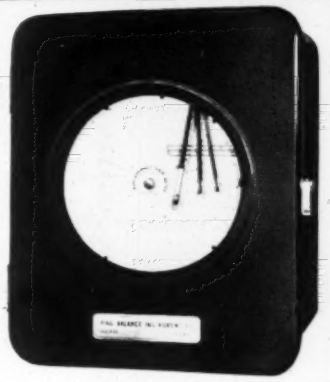
Micro-action Valve for Gages and Governors

For damping pulsations of pump governors and to eliminate oscillations of gage hands, new "Campbell Micro-Bean" can be installed on the pressure line to the dia-



phragm of a pump governor, is also effective as protection to any control valve, such as a back pressure or reducing regulator and for use with sensitive control instruments subjected to pulsating flow. The valve will handle steam, fuel oil, gas, water or other liquids, with simple adjustment for each viscosity. The Micro-Bean has a solid brass body in which a filter is inserted for protection from foreign matter. The valve has an extremely slight taper (48-to-1) so that sensitive control of the shut-off is effected. This slight taper minimizes the tendency to pinch off, under changing pressure conditions, to approximately 2% of what is usual in an ordinary valve, it is said. The micrometric control of the opening enables the operator to obtain the closest approach to full shut-off down to the last 0.0003" regardless of the line content. The device is universal in application for varied purposes up to 3000 lbs. pressure and will give any degree of stabilization desired by merely turning the valve. Any scoring which might eventually take place (it is said to be microscopic) can be simply ground out by shutting off the valve completely two or three times.—*J. A. Campbell Co., 645 East Wardlow Road, Long Beach, Calif.*

FLOW METERS FOR ALL PURPOSES



Model 656 Recording and Integrating Flow Meter with Pressure and Temperature Pens

★

HIGH PRESSURE METERS
Standard Differential Range—20" to 150" Water

LOW PRESSURE METERS
Standard Differential Range—1" to 8" of Water

★

Range Change Can be Made Without Taking Meter Out of Service

★

Write for Bulletin 410

RING BALANCE INSTRUMENT CO.
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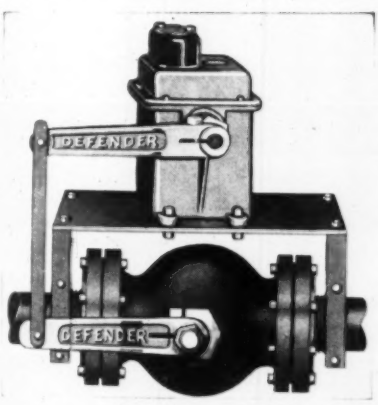

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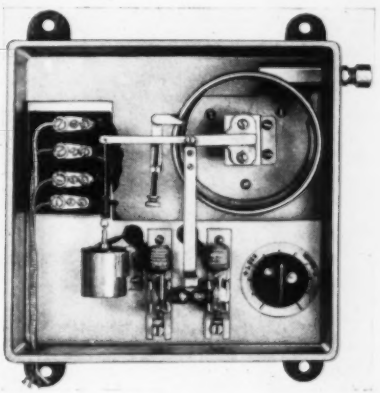
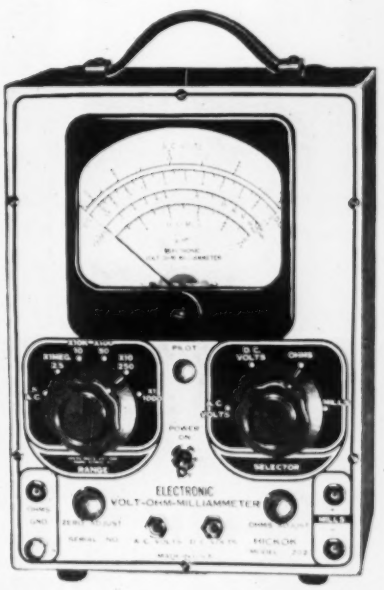


Electric Pressure Regulator." Principal application is in combustion control work, where "Type E-4" actuates two "Baracol Motors," one for stoker feed or drive and the other for forced draft fan. These two motors will synchronize and the resulting mode of control will be gradual. New "Type E-4" is available from "low pressure" up to "several thousands of pounds."—*Defender Automatic Regulator Co., 308 South 8th St., St. Louis, Mo.*

A-c.d-c. Volt-ohm-milliammeter

New "Model 202" a-c. and d-c. volt-ohm-milliammeter permits measurements to be made while the set is in operation without danger of damaging the test instrument through overload. Ranges: A-c. voltage in



five ranges to 1000 volts with input impedance of approximately 2.5 megohms; d-c. voltmeter in five ranges to 1000 volts with input impedance of 14 megohms; five ohmmeter ranges to 1000 megohms; five milliampere ranges to 1000 milliamperes. The 5" size indicator has total scale length of over 17". Pilot light is located on front panel. The power supply is entirely self-contained and operates on 110-volt 50-60 cycle a-c. It is provided with voltage regulator tube giving self-contained voltage regulation.—*The Hickok Electrical Instrument Co., 10525 Dupont Ave., Cleveland, O.*

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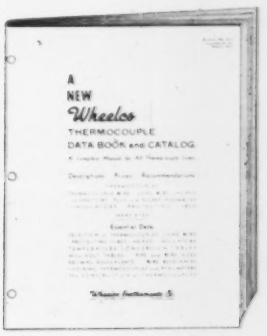
Every thermocouple user needs a copy of this new Wheelco Bulletin. It not only contains prices and descriptions of our complete line of thermocouples and thermocouple accessories but, in addition, gives recommendations for their selection and use. Essential data—the making of thermocouples, temperature conversion and millivoltage tables, wire resistances, etc.—are also included.

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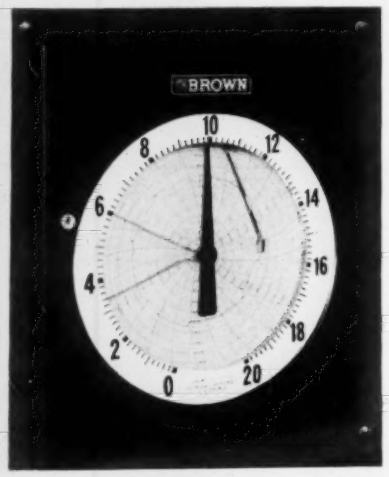
Round-chart Potentiometer

New circular chart potentiometer for indicating and recording temperature employs null-point potentiometer measuring circuit but its balancing system is entirely new: it is continuous; it has no galvanometer; it is said to be unique in speed of response and extremely sensitive to minute temperature changes. All live parts are enclosed. All amplifier components are oversize. Sensitivity may be adjusted for correct operation on any standard pyrometer range, thus making all amplifiers interchangeable. The balancing motor is a totally-enclosed brushless reversible induction motor with built-in gear



reduction. It drives pen, pointer and slide wire. Other features include: Pointer: 8" long, gear driven by balancing motor. Scale: concentric 320°, 1" black bold-face numerals on white field graduated same as chart. Pen and Arm: stainless steel, 8" long, ribbed reinforcement. Chart: 12" wide, pen travel of $4\frac{3}{4}$" full scale. Chart Clips: mounted on door, hold chart flat against chart plate. Gasket: synthetic sponge gasket, unaffected by oil, makes case dust- and moisture-proof. Motor Switch: double-pole toggle switch, easily accessible. Time Index and Pen Holder: for setting chart at correct time line. Pen holder supports pen when changing charts. Slide Wire: heavy wire dual wound on ceramic form, 25" long. Totally enclosed in metal container. Drive Mechanism: pen, pointer, and slide wire are directly connected to balancing motor at all times. A stainless steel cable, securely clamped to both slide wire and driving drums, provides a positive drive to the slide wire. This cable is not affected by atmospheric conditions. Case: rectangular, with rigid die-cast door. Streamline cam action combination handle and lock draw door tightly against case. Special baked, durable black enamel finish resists corrosion in moist, salt or acid atmospheres. Universal mounting permits flush or front-of-board mounting. — *The Brown Instrument Co., 4482 Wayne Ave., Philadelphia, Pa.*

Moisture-content Recorder for Tentered Cloth

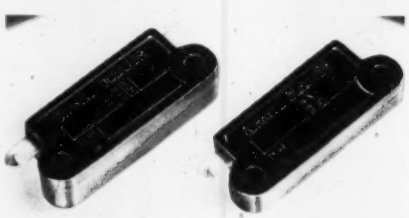
Development of the "Moist-o-Graph for Tenter Applications" is announced. This system consists of a recording instrument, a power unit, and a detector roll. In measuring the regain of tentered cloth, a detector roll is mounted at the delivery end of the tenter. This detector roll makes contact with the cloth as it leaves the tenter frame, and is connected with the Moist-o-Graph power unit by means of a special high-tension cable. A self-balancing electronic bridge circuit measures the conductivity of the cloth. Conductivity being proportional to regain, regain is recorded on the 12" size standard recorder. Chart is graduated 0-100. This is an arbitrary scale permitting utmost flexibility in application. Illustration shows recommended lint-proof cabinet. Components of system may be obtained without it.— *The Brown Instrument Co., 4482 Wayne Ave., Philadelphia, Pa.*

Conductivity Apparatus for Distilled Water, etc.

A new model of the "DW Checker" (see *Instruments*, Sept. 1939, page 244) is announced. Continuous automatic checking of distilled water or steam condensate is its function. For use with water stills the indicator is calibrated in parts per million of chloride ion in pure distilled water.—*Industrial Instruments, Inc., 156 Culver Ave., Jersey City, N. J.*

Midget Molded Capacitors

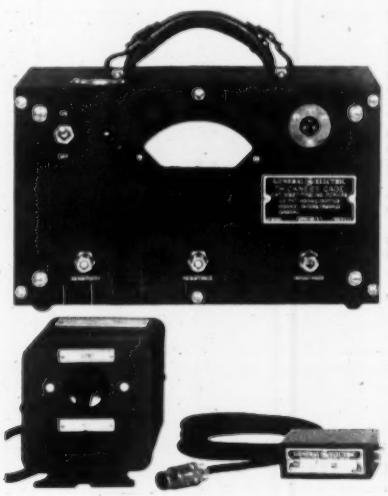
New "Type 8" unit is for use in applications requiring mica capacitors of small size and rigid mounting facilities. It is



molded in brown Bakelite. Its overall size is 1-$\frac{5}{8}$"x$\frac{5}{8}$", with thickness varying from 0.25" to 0.4" depending on the capacity. Insulated mounting holes, entirely independent of the terminal lugs, are molded in the Bakelite. Standard units are available in capacities from 0.001μfd to 1 mfd. Those up to 0.003 mfd. carry d-c. operating voltage ratings of 500; above this value the rating is 300 volts. Lugs are of tinned brass. Capacity and voltage ratings are clearly stamped on each unit. In addition to the standard unit, "Type 8" is also available in low-loss yellow Bakelite and can be supplied on special order with any or all of the following characteristics: capacity tolerance as close as ± 2%, temperature aged, with salt-water immersion seal against humidity, and for d-c. operating voltage rating of 800.—*Cornell-Dubilier Electric Corp., South Plainfield, N. J.*

Electric Thickness Gage

New type of electric gage, primarily designed for measuring the wall thicknesses of hollow aluminum airplane propellers, is applicable also to thickness measurement of any nonmagnetic metal when only one side is accessible, even if nonmagnetic metal is backed up by a magnetic metal. Thicknesses up to 1½", depending upon the electrical resistivity of the metal, can be measured within an accuracy of 5%. Brass sheeting, copper tanks and large pipes lend themselves to the use of the gage, it is said. The gage consists essentially of a bridge circuit, voltage amplifying equipment and an indicating instrument. The bridge circuit comprises two inductances with U-shaped cores and a differential transformer. The inductances serve as a gage head and an adjustable balancing head. The gage head, when placed against a nonmagnetic metal, sets up eddy currents within the metal



which change the impedance of the head and affect the circuit bridge balance. The eddy currents increase with the thicknesses of the metal; and the corresponding deflections of the indicating instrument are plotted upon a master curve for known thicknesses of a specific metal within the desired thickness range. When gage head is placed against unknown thickness of that same metal, the deflection reading is compared with a similar point on the master curve to determine thickness of test piece. It is essential that the contour of the test piece be the same as that of the pieces of known thicknesses from which the master curve was obtained. The higher the electrical resistivity of the metal the greater the thickness that can be measured. Brass can be measured in thicknesses up to 1½", whereas copper, which has a low resistivity, can be measured only to ¼" thickness. The gage head, encased in Bakelite, can be held in one hand for application against the metal. The remainder of the gage is contained in a steel carrying case and weighs about 30 lbs. The gage operates on 50- to 60-cycle a.c.— *General Electric Co., Schenectady, N. Y.*

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Bureau of Standards' New High-speed Cathode-ray Oscillograph

By OTTO ACKERMANN
Switchgear Engineering Dep't, Westinghouse Electric & Mfg. Co.

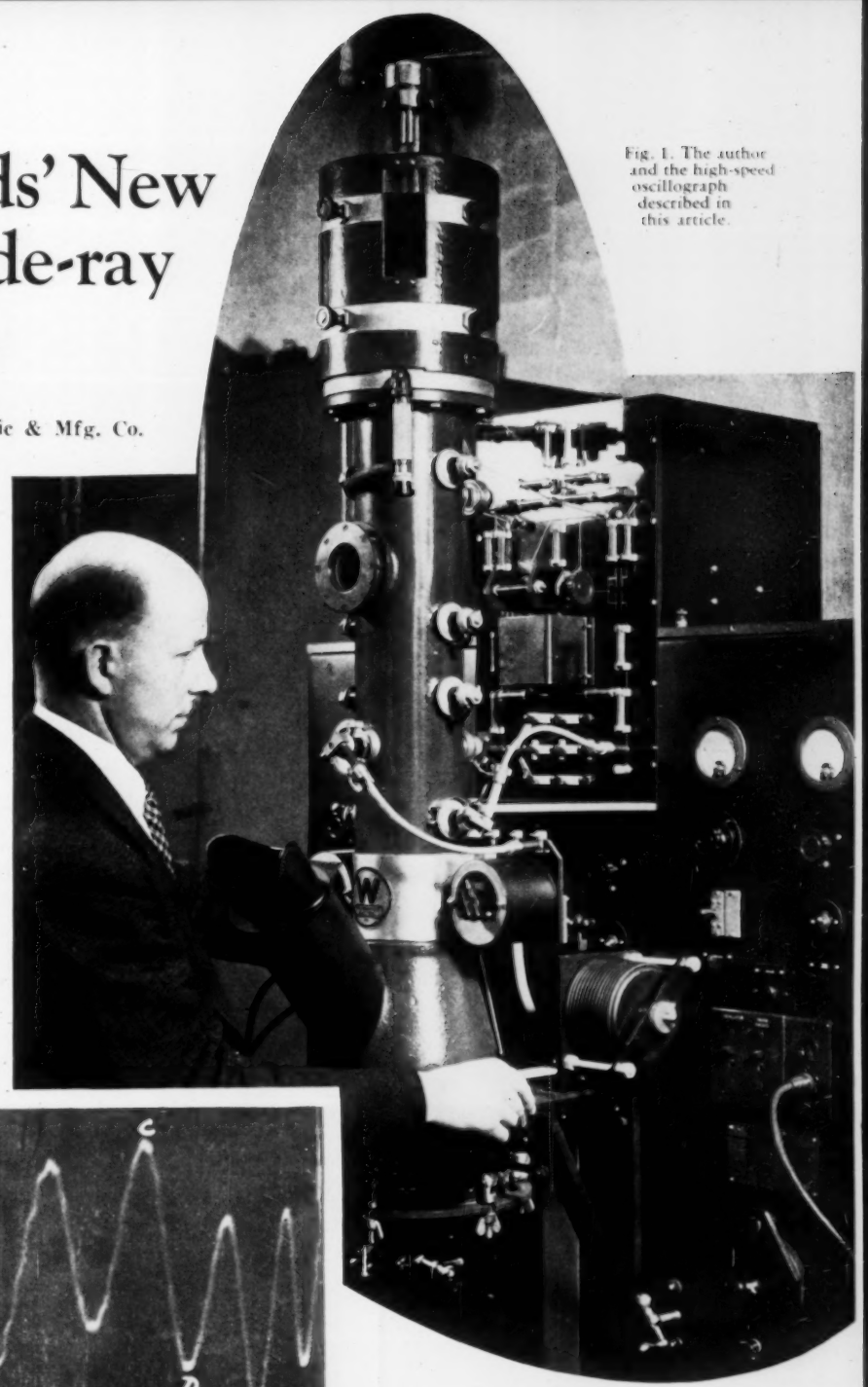


Fig. 1. The author and the high-speed oscillograph described in this article.

IN the new high-voltage impulse laboratory of the National Bureau of Standards is a cathode-ray oscillograph of the cold-cathode type embodying important refinements. Particularly important is the addition of a small metal bellows which acts as a pressure regulator. As with all oscillographs of this type the vacuum is continuously maintained by a pump which reduces the internal pressure to below that for satisfactory operation of the cathode beam, while a tiny trickle of air is admitted from the surrounding atmosphere by an extremely small needle valve. These valves frequently are quite erratic, making the necessary exact control of the vacuum difficult. It was discovered that the action of the needle valve is sensitive to slight changes in air pressure. This discovery was made one day while tests were being made with a cathode-ray oscillograph of this type while an air hammer was being used nearby. The slight changes of the air pressure caused by the exhaust of the hammer were sufficient to affect the oscillograph.

To stabilize the needle-valve operation a small air bellows has been applied through which the needle valve draws air for the evacuated oscillograph chamber. This bellows has worked so well that not only does it eliminate eratic action of the vacuum system but also it provides a better means of controlling the air inlet than by adjustment of the needle valve.

The Westinghouse cathode-ray oscillograph is of the so-called cold cathode type and is the only one of its kind commercially manufactured in America. At the present time seventeen such instruments (including somewhat earlier models and the one built for the National Bureau of Standards) are in use with various manufacturing companies, utilities and research institutions in this country and abroad.

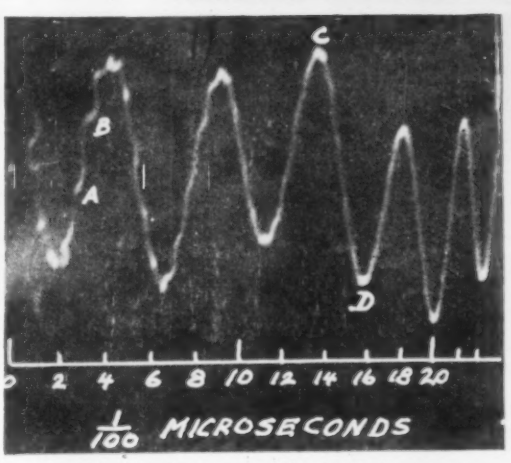


Fig.2. Typical record (5/6 actual size).

The hot-cathode oscillograph, on the other hand, is manufactured in many different types and is used in great numbers, particularly in the testing of low-voltage high-frequency circuits and as television tubes. Its elements of construction are similar to those of other electronic tubes with permanently sealed-off glass envelopes. In the minds of many it is associated with those interesting and often quite beautiful wave patterns which are produced on its fluorescent screen by so-called repeating phenomena which sweep the cathode beam over the same trace a great number of times, thus exciting the fluorescent material to high brilliancy. If a single sweep is to be made visible only nearly as well, the energy of the cathode beam—both in electron speed and density—must be raised considerably. In order to obtain permanent records, the flash-like picture on the fluorescent screen must be photographed. Thus the energy of the cathode beam is first converted into light, part of which reaches the photographic film through a system of lenses. This process, of course, entails appreciable loss. Nevertheless, sealed hot-cathode glass tubes are used for the recording of single transients of the order of milliseconds.

Where the phenomena are of the order of microseconds, the cold-cathode type comes into its own as the highest speed precision instrument. It achieves this by permitting the photographic film to be directly exposed to the cathode beam, by allowing a greatly increased cathode voltage (in this case 50,000 volts) and by sharply concentrating the emission spot at the "cold" cathode.

The cathode is called "cold" because it is not a heated filament nor a body heated indirectly to a rather uniform glow which permits thermionic emission. It is simply a small piece of aluminum exposed to high electric field stress and to the bombardment of ions which precipitate and concentrate the emission of electrons from a spot as small as the point of a needle.

As to the direct exposure of the film to the cathode beam, this necessitates that the cathode tube be opened and then again evacuated whenever it is loaded with a roll film (which is done much in the same manner as with an ordinary camera). The pumping process, its machinery and the

regulation of the vacuum have been perfected and simplified to a degree which practically eliminates vacuum difficulty in the operation of the instrument. The oscillograph pumps out to a working vacuum in 10 minutes or less.

By these means—concentrated "cold" emission, high electron speed and direct film exposure—extremely high writing speeds are obtained. It is hard to agree on the maximum writing speed of any instrument because this depends so much on what one considers a satisfactorily well defined trace and because of the difficulty to determine the actual times in which such traces are written. This is illustrated by Fig. 2, the record of a 22-million-cycle frequency the section *CD* of which is 1.5" long; from this the average speed in that part figures 66" per microsecond. In the beginning of the record the 22-megacycle frequency shows still faster components due to traveling waves in the short leads of the circuit. The voltage at the oscillograph plates moves in jerks—wave fronts—the steepness of which hardly can be determined with accuracy. At any rate, the writing speed might well be five to ten times that shown between *C* and *D*. For the latter an accurate figure was given above in terms of inches and microsecond which are the magnitudes with which one has to work when analyzing such records. It probably is the urge for brandishing impressive figures which has developed the usage of expressing oscillograph writing speeds in miles or kilometers per second. In such terms the above-mentioned figure would appear as about 1000 miles per second.

Minimizing Errors in Metering Pulsating Flows

By WILLIAM MELAS

In Charge of Instrument Engineering, Cochrane Corp., Philadelphia, Pa.

ERRORS which result from pulsating flow may be explained by the following example: Assume a steam flowmeter with a mercury manometer having a range of 75 inches water head representing a maximum capacity of 10,000 pounds per hour; and assume pulsations of flow such that at one instant the differential head is 48" of water and the next instant 3" of water. The flow corresponding to 48" is 8000 lbs./hr. while for 3" it is 2000 lbs./hr. The inertia of the fluid in the pressure piping and of the mercury in the manometer prevents the recorder from following the quick changes in differential. The recorder would take a position corresponding to an average differential, $\frac{1}{2} \times (48 + 3)$, or $25\frac{1}{2}$", and would thus register 5831 lbs./hr. However, with the flow for one half the time at 8000 lbs./hr. and then at 2000 lbs./hr. for the other half of the time, the actual average flow would be $\frac{1}{2} \times (8000 + 2000)$, or 5000 lbs./hr. Therefore, the pulsating flow would result in the recorder reading 16.6% high.

The magnitude of the error due to pulsating flow depends upon the frequency and degree of pulsation, the volume and other characteristics of the piping and the compressibility of the fluid. In any case, it is important that pulsations be damped or eliminated in order to measure the flow accurately. The following arrangements are recommended:

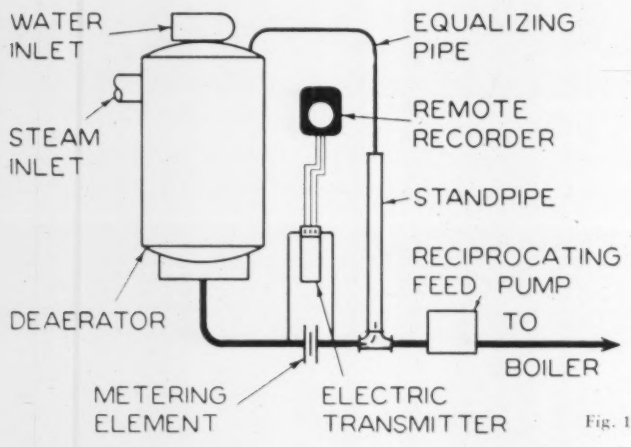


Fig. 1

Orifice on Suction Side of Reciprocating Pump.—The (patented) method shown in Fig. 1 enables a Cochrane Flow Meter to measure accurately water taken by a reciprocating pump from an open feed-water heater or other receptacle having a free water surface. A stand-pipe located between the pump and orifice is vented back to the heater and absorbs the pulsations created by the pump. While the water level in the standpipe rises and falls by reason of the pulsations, the flow through the orifice remains fairly constant and allows the meter to respond to a head corresponding to the average flow. The vent line from the standpipe leads to the space above the free liquid level in the vessel supplied. Where this is impracticable, the standpipe or chamber may be supplied with compressed air.

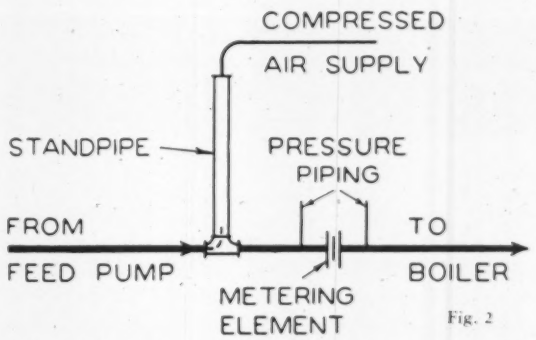


Fig. 2

Orifice on Discharge Side of Reciprocating Pumps.—When lack of pressure head or other conditions prohibit the orifice being placed on the suction side of the pump, the arrangement illustrated in Fig. 2 can be used. Here the orifice is located on the discharge side. The water is directed upward into the chamber, where the pulsations cause the compressed air to contract and expand alternately. The pulsations are thus absorbed in the chamber and allow accurate readings to be obtained with the flowmeter. This arrangement is also suitable for use in measuring liquids other than water.

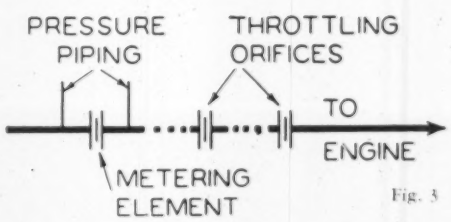
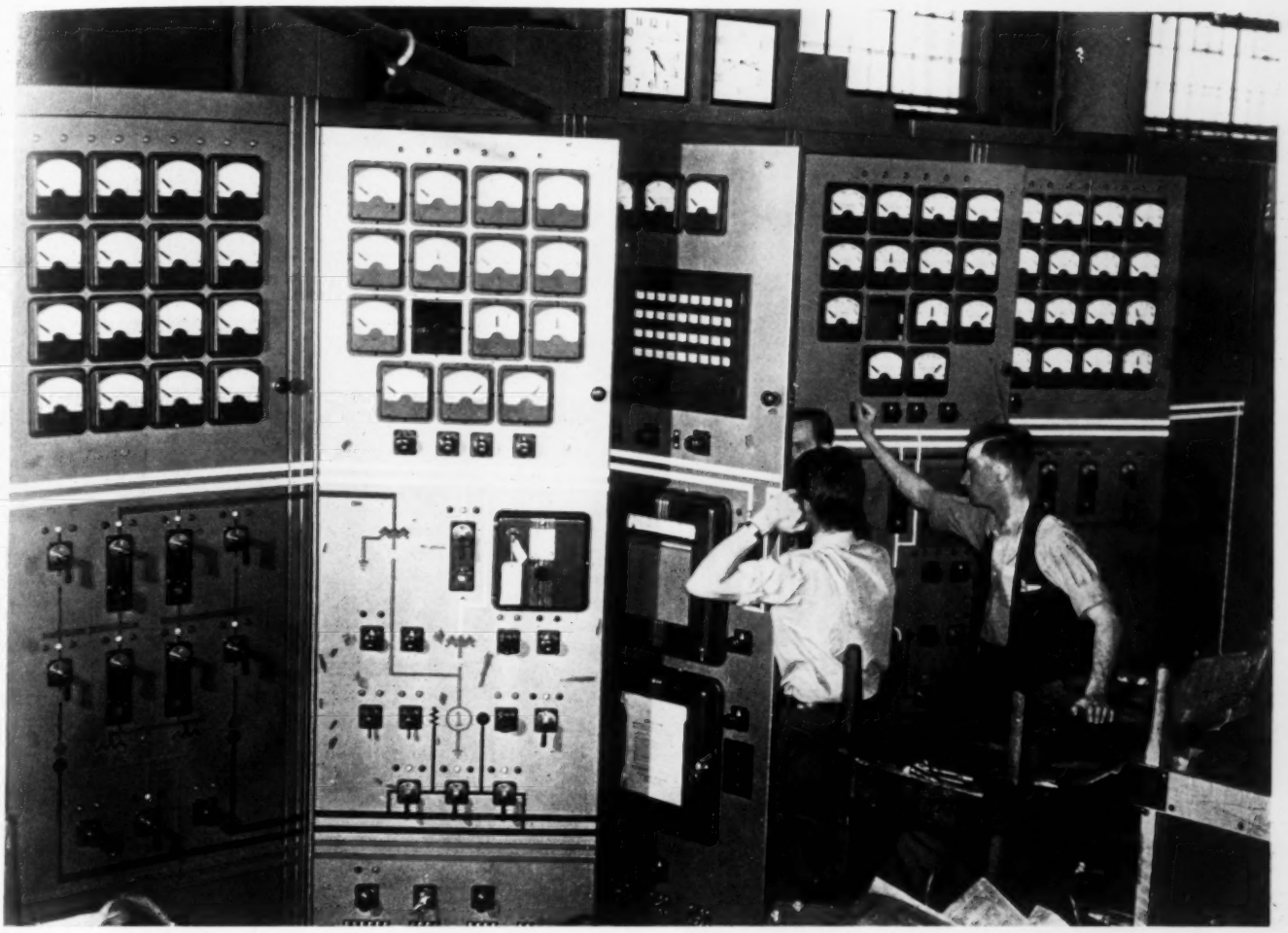


Fig. 3

Eliminating Pulsations in Steam, Air and Gas.—In measuring a compressible fluid such as steam, air or gas, satisfactory results may be attained by installing sufficient receiver capacity and causing the fluid to undergo one or more abrupt velocity changes. This allows the fluid to compress and expand in the receiver space and consequently damps out the pulsations. If a large receiver is not available, "throttling orifices," Fig. 3, may be used to produce changes in velocity. These orifices may be economically constructed of thin sheet metal and inserted between flanges in the line. However, this method results in a pressure loss which is not recoverable, and therefore the use of a receiver may sometimes be preferable. Neither of these methods is available for measuring water or other liquids, since these fluids are practically incompressible.



Modernization of Instrument Boards

By H. S. EDGERLY
Philadelphia Works, General Electric Company

THREE distinct trends in the design, appearance, and construction of control boards are becoming apparent. First, today's equipments have been streamlined by semiflush mounting of all instruments, meters, relays and control devices. Second, the somber black that predominated on control boards until recently is giving way to colors that will harmonize pleasantly with general station appearance. Third, today's boards are completely assembled at the factory and shipped as a unit with all instruments in place.

These trends show up unmistakably in the control board pictured on this page. It is the main control board for a 160,000-kw. steam station* being checked and tested at General Electric's Philadelphia Works before shipment.

The color of this board is light bronze. Other colors used have included pearl gray, cream, green, and dark bronze. The semiflush mounted instruments and meters are uniformly black. A striking note is added by the efficient color system employed for the mimic bus-work on the face of the board. In reality, this constitutes a one-line diagram of the station power system, and with red, white, black, and blue to represent different system voltages, operation of the board is considerably simplified.

Semiflush mounting of all instruments obtains an additional advantage beside improving the appearance of the board. All scales are in the same plane, making it much easier to read the instruments than it would be if the projection of the indicating devices varied.

Of course, the board was shipped completely assembled. None of the instruments was removed for separate packing. Present design of control boards and instruments alike is so sturdy that it is no longer considered necessary even to block moving parts of the instruments for shipment. It will be noted also that instruments are mounted on swinging doors and this has been found satisfactory.

The clock at the left atop the board is a standard Warren motor clock. The right hand clock indicates the time error of turbine frequency. This clock is operated through a differential gear and is controlled from the frequency of the turbine source and a standard frequency source. Thus the relation of turbine frequency to standard time is indicated.

Directly below the three instruments at the top of the panel underneath the clocks are 36 annunciators which automatically warn the operators of the occurrence of any abnormal conditions that might be detrimental to the two 80,000-kw. turbine-generators or their accessories. The annunciators are operated through relay contacts which close due to these abnormal conditions. When contacts close they energize semaphore drops to which are attached cards definitely stating the source of trouble. At the same time an alarm signal is sounded to attract the operator's attention.

Below the annunciator is a frequency recorder and a voltage recorder. The indicating instruments neatly grouped on the other panels include d-c. ammeters and voltmeters, wattmeters, var meters, and potentiometer type temperature indicators. The large control switches on the middle sections of the panels are for breaker operation and synchronizing.

* of the Central New York Power Corp., at Oswego, N. Y. At this time it is installed and in operation.—EDITOR

Factors Affecting the Accuracy of Differential-type Frequency Meters

By E. W. CLARK

Instrument Engineering Section, General Electric Company, Lynn, Mass.

FREQUENCY meters for determining the instantaneous frequency of alternating-current circuits are comparable in appearance to conventional ammeters, voltmeters, and other common types of instruments. Inside, however, the components and circuits are different.

Basically, the working parts of a differential-type frequency meter consist of two units. One is a circuit, or circuits, designed so that changes in the frequency of the impressed voltage will cause changes in either or both the magnitude and phase angle of the current flowing in the circuit.* The other unit is a device to measure and translate into frequency, by means of a pointer moving over a calibrated scale, the current that is controlled by the first unit.†

It is known theoretically and it has been determined experimentally that one of the best ways of obtaining a frequency meter to indicate small changes in frequency accurately is to make use of two tuned circuits—one tuned just above the highest frequency to be measured and the other just below the lowest frequency to be measured—and determine the ratios of the currents by an electrodynamic moving-iron mechanism.

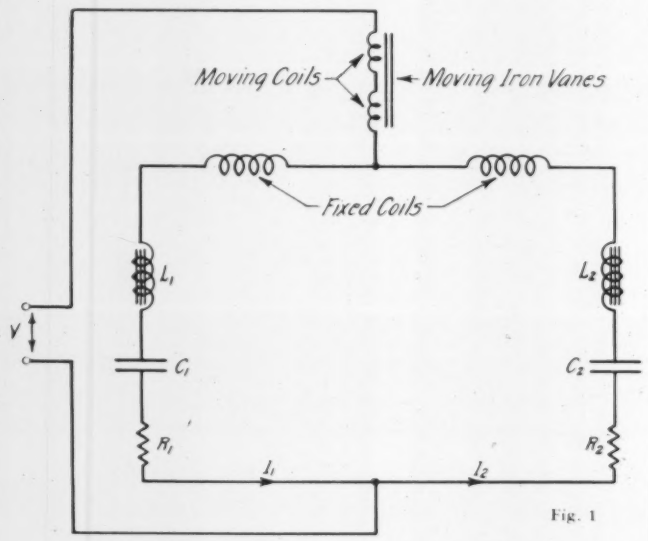


Fig. 1

Briefly, such an instrument consists of two tuned circuits connected to two fixed coils. Inside these is an armature coil and iron vane unit free to turn in jeweled bearings and carry a pointer across a calibrated scale. A schematic diagram of this type of instrument is shown in Fig. 1, and a representative set of vector diagrams for a 55-60-65 cycle instrument is shown in Fig. 2. Note that the iron vanes always tend to hold the armature at approximately mid-scale position. However, the moving coils can either produce no torque or tend to turn the armature up or down scale, depending on the values of $(I_1 + I_2)$, $(I_1 - I_2)$, and their phase relationships.

To insure stability of the tuned circuits, all capacitors used in electrical resonance type frequency meters should be the best available and even then should be hermetically sealed, heat-treated, and aged. The inductance coils, too, must be exceptionally well-built and stable. As B. W. St. Clair stated in his *Instruments* article: "If it were possible to produce inductors and capacitors of sufficient constancy it would be feasible to build instruments of 59.9 to 60.1 cycle scale range."

While the majority of electrical resonance type frequency meters cover limited ranges like the 55-65 cycle scale shown in Fig. 4, wide-range instruments having scales 20-90 cycles can be obtained. Also available are special types such as speed indicators, with scales marked 60% low, zero (corresponding to the normal frequency of the circuit), 20% high in place of customary frequency markings.

It is rather difficult to give a one-figure statement of accuracy for electrical resonance type frequency meters since accuracy must be composed of several individual errors that can be either positive or negative in the following manner:

Scale calibration error. This can be either positive or negative as in any other instrument, and depends upon the care with which the instrument is calibrated and the scale marked.

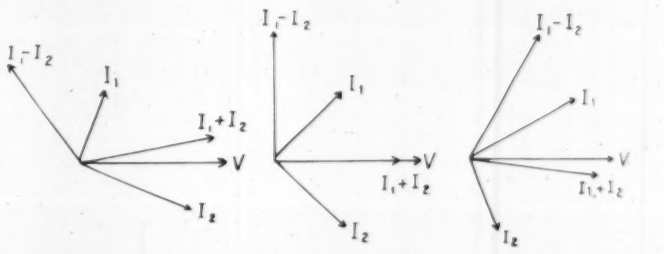


Fig. 2

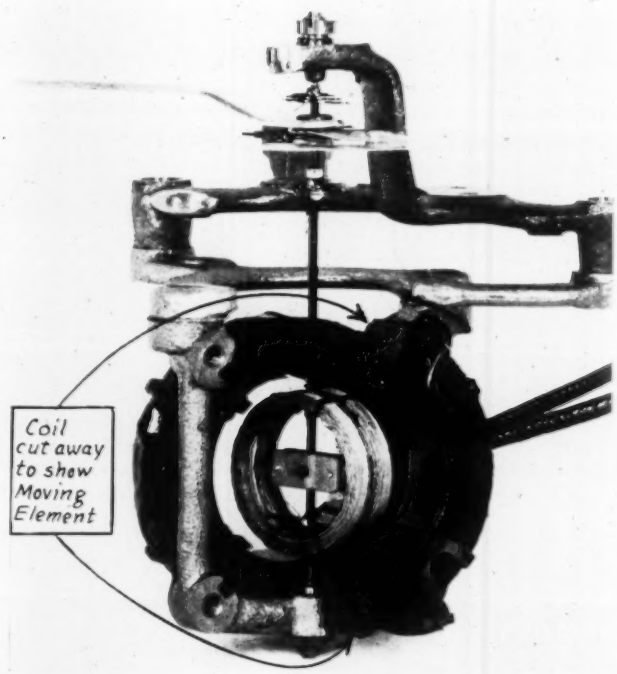


Fig. 3. Movement of the "Type P-3" Frequency Meter.

*For the underlying theory and some details, see
B. W. St. Clair. Indicating Frequency Meters. *Instruments*, Vol. 2, Nov. 1929, pages 371-377.
P. A. Borden and M. F. Behar. Electrical Frequency Meters. *Instruments*, Vol. 7, Aug. 1934, pages 165-167.

†For a complete description of this device, see
T. A. Rich. An Electrodynamic Moving Iron Mechanism for Electrical Measuring Instruments. *General Electric Review*, Vol. 38, July 1935, pages 334-338.

Self-heat error. This error depends upon the circuit constants, the length of time the instrument was in the circuit prior to calibration, and the length of time the instrument is in the test circuit before readings are taken. These errors should be extremely small and can be calibrated out on instruments intended for continuous use.

Voltage error. This depends on the restoring torque of the lead-in spirals to the moving system and the constants of the circuit. Over the usual voltage ranges of, say, ±20% of rated voltage, the circuit of the frequency meter need not change appreciably. Therefore, low-torque spirals that affect the indication only slightly can be used. When the point of zero spiral torque is at mid-scale, the tendency is for the pointer to deflect farther from its mid-scale position with increasing voltage, and less than normal with decreasing voltage. With a voltage higher than normal, such a frequency meter tends to read high on the right and low on the left of center scale. It reads low on the right or high on the left side of center with a voltage lower than normal. At approximately mid-scale there is practically no error due to change in voltage up to ±20% rated voltage.

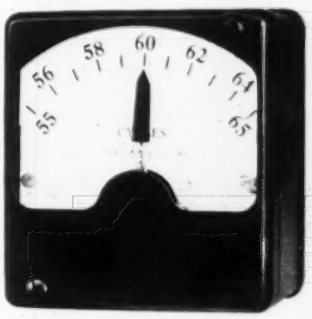


Fig. 4. Outside view of "Type AD-6" Frequency Meter.

Ambient temperature errors. These errors may be positive or negative. They are caused by changes in circuit constants such as resistance and capacitance and are reduced to the minimum by the design and choice of the instrument constants. All General Electric standard high-sensitivity instruments (59-61 and 59.5-60.5) are actually temperature-compensated. As a result a ±20°C. temperature change does not cause more than ±0.02 cycle change in indication.

Wave form errors. These errors are lower in tuned-circuit instruments than in any other kind and are negligible unless extremely poor wave shapes, containing several percent harmonics, are encountered.

Typical accuracies on G-E Type P-3 frequency meters follow:

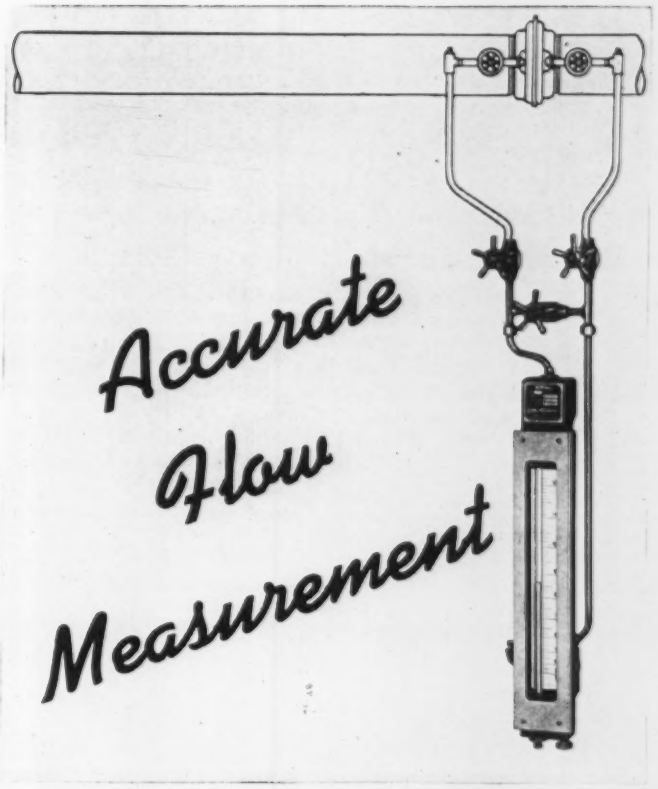
Frequency Range	*Accuracy*[1]	*Temperature Coefficient*[2]	*Self heat*[3]	*Voltage Error*[4]
22.5-27.5	0.2	0.01	0.2	0.02
27-35	0.2	0.01	0.2	0.02
37-43	0.2	0.015	0.1	0.01
46-54	0.2	0.015	0.1	0.01
55-65	0.2	0.015	0.1	0.01
59-61	0.2	0.0015	0.1	0.01
20-90	0.3	0.015	1.0	0.05

1. Accuracy: Initial guaranteed accuracy in % of normal frequency at rated voltage on a sine wave circuit at 25°C. (20-90 cycle instrument accuracy is in terms of % of full scale.)
2. Temperature coefficient: In % per degree C. which will not be exceeded in the instrument over ±20°C. range from normal.
3. Self heat: The variation in indication due to standing under load at rated voltage does not exceed the percentages given in the table.
4. Voltage error: In % per volt maximum that can be expected due to ±20% of rated voltage.

General Electric indicating switchboard types AD-6, AD-7, (rectangular) and AR-2 (round) frequency meters have initial rated accuracies of 1% for 22.5-27.5 cycle instruments, and 0.5% for 45-55 or 55-65 cycle instruments.

Type AH-12, horizontal edgewise G-E frequency meters, have similar accuracy ratings, but in addition 59-61 and 59.5-60.5 cycle instruments are rated ¼% accuracy.

As described above, it should be remembered that under normal operating conditions, the actual errors encountered are much less than the above indicated possible maximum. In fact, many short-range instruments with 59-61 and 59.5-60.5 cycle scales have been carefully tested over a period of years under normal operating conditions of temperature and humidity, and have continuously checked within 0.02 cycles of being correct.



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Recent Progress in Applications of Dry-disk Photocells

By ANTHONY H. LAMB
Engineer, Weston Electrical Instrument Corporation, Newark, N. J.

TEN years ago, in May 1931, the first commercially practical dry-disk photocell came into being. Fig. 1 shows its birth certificate: a record of the electrical energy produced by the first of these cells during sensitization. During ensuing months, a number of these cells were released for field trials. Finally, late in 1931, the first announcement[1] of their general availability to industry was made. This announcement of the Photronic Cell stated that for many years before that time, photocells had ceased to be laboratory curiosities and had taken a place as established industrial tools, but that each type had inherent limitations or had to be used in conjunction with expensive auxiliary equipment. The announcement went on to describe the characteristics of the new type of cell, giving facts and figures. Simultaneously, detailed tables and curves were released to interest workers. Almost immediately there were brought out the first simple portable photometric instruments[2, 3] whose operation was made possible by the characteristics of the new cell. World-wide attention was attracted to these characteristics when various instruments embodying the new dry-disk cells were used by numerous observers of the solar eclipse of August 31, 1932. The front-cover photograph of the September 1932 issue of *Instruments* showed scientists using such equipment at the Magog (Canada) eclipse station. Numerous records (example, Fig. 2) at stations in and out of the zone of totality were made with such ease and accuracy that the world of science gave the new dry-disk cell its entire approval.

Meanwhile, industrial *measurement* applications were being extended, as well as industrial control applications requiring exact measurements rather than mere interruptions of light beams; and in October 1932 the writer gave the first outline[4] of the new possibilities. Since then, there has been a phenomenal increase in the number and diversity of the industrial measurement and control applications of dry-disk photocells.

In reviewing these applications and their expanding commercial importance, we encounter a peculiar situation. The basic idea of using a beam of light as a control element has been so fascinating, even to laymen, that there has been a tendency to overate "stunt" applications, in comparison to those which are economically justified on a practical commercial basis. Thus, certain spectacular applications—in fields like crime detection, for example—have been widely popularized while they still existed only on paper, or in trick set-ups where the costs were out of keeping with the result achieved. In this review, therefore, there seems no reason to discuss photocell applications developed for their novelty value or scientific publicity value alone. With dry-disk photocells moving out into use in volume for applications which stand on their own feet commercially, we are able to restrict ourselves to those which perform essential functions better than other methods of achieving the same end, or do things that previously were never possible at all.

It is significant, too, in this connection, that many of the widely publicized photoelectric stunts require only the most

[1]New Photoelectric Cell. *Instruments*, Vol. 4, Nov. 1931, page 641.
[2]Simple Illuminometer. *Instruments*, Vol. 5, Jan. 1932, page 22.
[3]Direct Reading Illuminometer. *Instruments*, Vol. 5, May 1932, page 136.

[4]Anthony H. Lamb. "Free Electricity While the Sun Shines"—How Photronic Cells are Employed to Measure Daylight, Operate Beacons, etc. *Instruments*, Vol. 5, Oct. 1932, pages 230-232, 236, 237.

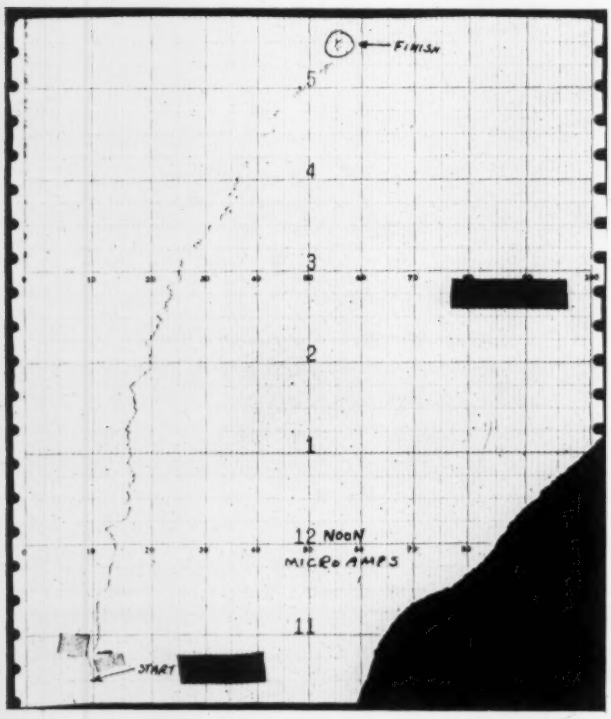

Fig. 1. "Birth record" of first Photronic cell.

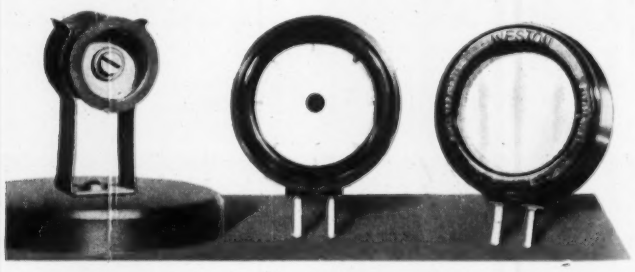

Fig. 3. Early experimental cell; 1931 cell; 1941 cell.

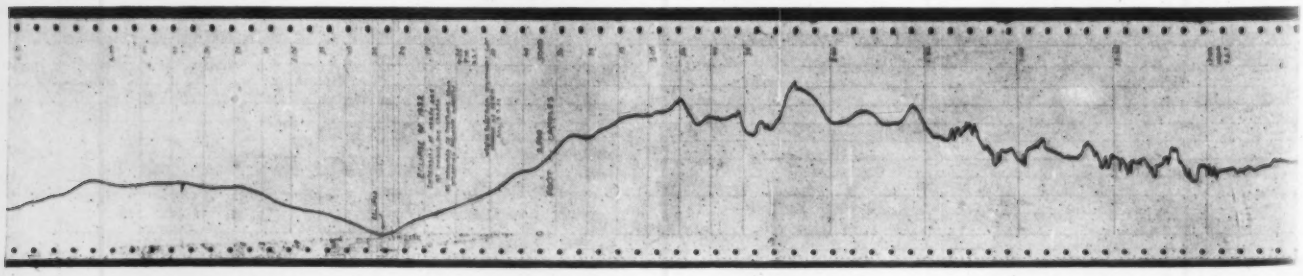

Fig. 2. Record of light intensity at the Magog station from noon (right) to 6:30 p.m. (left) on the day of the eclipse.

MANUFACTURERS' NEW LITERATURE

In this department we report ALL pieces of NEW literature pertaining to Instrumentation, received from the manufacturers. Readers may secure without cost (unless noted) any or all items reported here, by filling out and mailing the card.

I-231 **Transformer Catalog.** Form 140c, 8½" × 11", 28 pages, covers complete line of output, audio and miscellaneous transformers, filter chokes, transmitter kits, etc. Standard Transformer Corp., Chicago, Ill.

I-232 **Newer Physiology Apparatus.** Bulletin, 8" × 11", 4 pages, describes and illustrates Parmenter-McLean cardiotachometer and heart lever, muscle levers, metallic bellows manometers, erographs and mercury manometers. Phipps & Bird, Inc., Richmond, Va.

I-233 **"Precision Electrical Instruments."** Catalog I-61, 8½" × 11", 4 pages, lists d-c. voltmeters, ammeters, millivoltmeters, galvanometers, microammeters, milliameters, ammeter shunts etc. DeJur-Amsco Corp., Shelton, Conn.

I-234 **Capacitors.** 1941 Abridged Catalog No. 185A, 8½" × 11", 20 pages, covers mica receiving and transmitting, replacement paper, tubular paper, dykanol and wet and dry electrolytic capacitors. Cornell-Dubilier Electric Corp., New Bedford, Mass.

I-235 **Precision Instrument Screws, Nuts, Washers, Taps, Dies and Counterbores.** Bulletin U-41, 8½" × 11", 8 pages, describes and illustrates brass and steel instrument screws, hexagon machine screw nuts, round finished washers for machine screws, taps, dies and machine screw counterbores. The R. Y. Ferner Co., 131 State St., Boston, Mass.

I-236 **Bushing Test Set.** Catalog E-54(4), 7¾" × 10½", 12 pages, describes set for measurements of power factor and capacitance of installed bushings and insulators. Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia, Pa.

I-237 **Rotary Selector Switches.** Bulletin, 8½" × 11", 4 pages, covers thermocouple and resistance thermometer switches, also special thermocouple switches. Includes drilling dimensions for mounting switches flush on panels. Lewis Engineering Co., Naugatuck, Conn.

I-238 **Battery Charger.** Catalog Page 27, 8½" × 10½", 2 pages, covers F-50 and F-51 portable Unitron charger, an all-purpose rectifier for fast or slow charging or testing, operates from 110 or 220 volts. Allen Electric & Equipment Co., Kalamazoo, Mich.

I-239 **Transparent Draft Gage.** Bulletin No. 25, 8½" × 11", 1 page, describes and illustrates new Visi-Draft gage for use in the field. Scale is graduated in 0.01" divisions; gage comes in carrying case 4" × 3" × 1". F. W. Dwyer Mfg. Co., 565 W. Washington Blvd., Chicago, Ill.

I-240 **Water Conditioning System.** Publication 3015, 8½" × 11", 6 pages, describes and illustrates electrical controls for proportional chemical feeders for water conditioning equipment. Cochrane Corp., 17th St. & Allegheny Ave., Philadelphia, Pa.

I-241 **Push-Pull Vibrators.** Replacement Manual, Catalog 1-41, 8½" × 11", 16 pages, gives construction, application and advantages of double-action vibrators, as well as a complete replacement chart and cross index. The Turner Co., 800 17th St., Cedar Rapids, Iowa.

I-242 **Carbonated Beverage Control System.** Bulletin No. 48-1, 8¾" × 11½", 4 pages, covers general principles of carbonator, carbonation control and the recording thermometer, recording pressure gage and Air-O-Motor valve. Brown Instrument Co., Wayne & Roberts Aves., Philadelphia, Pa.

I-243 **Pulsation Damper.** Bulletin, 8¾" × 11½", 1 page, describes and illustrates damper used to protect gages and recorders where the surging pressures are exposed directly to pumps, compressors, steam lines. Martin-Decker Corp., 3431 Cherry Ave., Long Beach, Calif.

I-244 **Steam Sample Degasifier.** Publication 3020, 8½" × 11", 4 pages describes and illustrates device for condensing a steam sample, separating non-condensible gases for analysis and degasifying the condensed sample for conductivity tests for determination of carryover. Cochrane Corp., 17th St. & Allegheny Ave., Philadelphia, Pa.

I-245 **Automatic Control for Dye Machines and Vats.** Bulletin ID527, 8" × 10½", 8 pages, describes and illustrates Dyemaster which automatically controls the time and temperature of each step in the dyeing process. The Bristol Co., Waterbury, Conn.

I-246 **Rotameters.** Catalog Section 50-A, 8½" × 11", 8 pages, covers electrically operated, remote indicating, recording and integrating Rotameters. Several different types of transmitting systems including mechanical, magnetic, electronic and inductive are used, with this catalog section being devoted to induction bridge transmitter types. Fischer & Porter Co., 24 County Line Rd., Hatboro, Pa.

I-247 **Aircraft Instruments.** Catalog Section 43-347, 8⅜" × 10⅞", 8 pages, describes application and construction of voltmeters, ammeters and volt-ammeters. Price list gives dial ranges and style numbers. Physical dimensions are shown on line drawings which also give drilling plans for the various types. Dept. 7-N-20, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

I-248 **Insulation Resistance Testing Instruments.** Bulletin No. 430, 8¼" × 10¾", 8 pages, describes model B-5 Megohmer with range of 0-200 megohms for insulation tests, 0-2000 ohms for low resistance measurements and has two d-c. voltmeter scales 0-300 and 0-600 volts. Herman H. Sticht Co., Inc., 27 Park Pl., New York City.

I-249 **Moist-O-Graph for Tenters.** Bulletin No. 93-5, 8¾" × 11½", 14 pages, covers development, operating principle, description of Moist-O-Graph and its application as a recorder. Brown Instrument Co., Wayne & Roberts Aves., Philadelphia, Pa.

I-250 **Aircraft Fuses.** Bulletin, 8½" × 11", 4 pages, describes and illustrates general current characteristics and general dimensions of fuses, showing typical aircraft fuse panels. Also included are fuse mountings, mercury switches and low voltage Tattelite tester. Littelfuse Inc., 4757 Ravenswood Ave., Chicago, Ill.

I-251 **"Instrumentation and Automatic Control in the Oil Refining Industry."** Flexible cloth bound book, 6" × 9", 192 pages, describes construction and operation of Brown pyrometers, thermometers, pressure recorders, flowmeters, liquid level instruments, pneumatic remote transmission, and air-operated automatic controllers. Parts VIII and IX describe special controllers; and Part X is on control valves. Then there is an appendix containing thermocouple wire data, flowmeter data, electric flowmeter data, misc. tables, drilling and mounting dimensions. Book will be sent without charge to *Instruments* readers. The Brown Instrument Co., 4482 Wayne Ave., Philadelphia, Pa.

I-252 **General Radio "Experimenter."** June 1941, 8 pages, is devoted to article entitled "The Vibration Meter—A New Electronic Tool for Industry," also announces preparation of service and maintenance notes. General Radio Co., 30 State St., Cambridge, Mass.

I-253 **Recording Instruments.** Bulletin, 8¼" × 10¾", 4 pages, describes and illustrates air temperature recording thermometer with bi-metal coil, pen arm fixed direct to it and electrical operation recorder, electromagnet operated with armature fastened to pen arm. Practical Instrument Co., 2717 North Ashland, Chicago, Ill.

I-254 **Du Mont "Oscillographer."** Vol. 3, No. 12, Vol. 5, No. 1, 6" × 9", 4 pages, is entirely devoted to article entitled "Dynamic Balancing of Small Rotors by Means of the Cathode-Ray Oscillograph." Allen B. Du Mont Labs., Inc., 2 Main Ave., Passaic, N. J.

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I-256 **Feed Water Chemistry.** Publication 3006, 8½" × 11", 12 pages, discusses boiler feed water analyses—the fundamental ionic analysis, ionic report with equivalents, hypothetical combination of water analyses, etc. Cochrane Corp., 17th St. & Allegheny Ave., Philadelphia, Pa.

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I-258 **Instrumentation for Plating Tanks.** Bulletin No. 81-2, 8¾" × 11½", 6 pages, covers characteristics of system and applicational data, includes diagram of temperature control system for plating tanks, records of bath temperature controlled from bath temperature and from circulating water. Brown Instrument Co., Wayne & Roberts Aves., Philadelphia, Pa.

I-259 **Timestarters.** Descriptive Data 8512, 8⅜" × 11", 2 pages, describes and illustrates remote controlled Timestarters for constant speed d-c. motors up to 10 h.p. Application and installation instructions are covered. Dept. 7-N-20, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

I-260 **Aerovox "Research Worker."** Vol. 13, No. 3, 4 pages, contains article entitled "Fixed Condensers in Radio Transmitters." Aerovox Corp., New Bedford, Mass.

I-261 **Voltmeters and Ammeters.** Bulletin 574, 8¾" × 11¾", 4 pages, describes and illustrates portable recording voltmeters and ammeters, listing various applications. The Bristol Co., Waterbury, Conn.

I-262 **Solution Control.** Sheet, 8½" × 11", 1 page, covers analytical sets for measuring and controlling the pH of solutions—colorimetric comparator method used for nickel, acid zinc, copper, cyanide brass and other solutions. Kocour Co., 4624 S. Christiana Ave., Chicago, Ill.

I-263 **Cable Terminals.** Bulletin, 8¼" × 10½", 4 pages, describes and illustrates Types S and SS sectional terminals and other types of cable terminals, terminal plates and terminal accessories. Cannon Electric Development Co., Los Angeles, Calif.

I-264 **Bodine "Motorgram."** Vol. 21, No. 3, 8½" × 11", 4 pages, contains feature article on designing small motors for quiet operation, data on tachometer tester and other brief items. Bodine Electric Co., 2250 W. Ohio St., Chicago, Ill.

I-265 **Fluorescent Testing Instruments.** Bulletin, 8½" × 11", 2 pages, describes and illustrates Fluorotest Junior and Senior models—used to diagnose line voltage, lamp voltage, condition of auxiliaries such as reactors, ballasts, compensators, starters, etc. of a wired fluorescent lighting fixture. Dayton Acme Co., 2339 Gilbert Ave., Cincinnati, Ohio.

I-266 **Aerovox "Research Worker."** Vol. 13, No. 4, 4 pages, contains article entitled "R.F. Power Amplifier Operation." Aerovox Corp., New Bedford, Mass.

I-267 **Metal Bellows and Bellows Assemblies.** Bulletin No. 130, 8½" × 11", 28 pages, catalogues seamless metal bellows and assemblies for use by instrument, appliance and machinery manufacturers, covers applications of seamless metal bellows, both roll-formed and hydraulically-formed in single and multi-ply types. The Fulton Sylphon Co., Knoxville, Tenn.

I-268 **"Cenco News Chats."** No. 33, 7¾" × 10¾", 28 pages, describes and illustrates a number of laboratory instruments and new ideas for laboratory work. Central Scientific Co., 1700 Irving Park Blvd., Chicago, Ill.

I-269 **Hot Blast Control Systems.** Bulletin No. 27-7, 8¾" × 11½", 8 pages, describes automatic hot blast control, advantages and principles, listing forms and models available and including three figures showing hot blast control system, Freyn mixing valve and typical chart section. The Brown Instrument Co., Wayne & Roberts Aves., Philadelphia, Pa.

I-270 **Panel Instruments.** Catalog A, 8½" × 11", 12 pages, covers line of electrical instruments of the d-c. D'Arsonval moving coil, a-c. double iron repulsion and electro-dynamometer types; also several precision portables. The Triplett Electrical Instrument Co., Bluffton, Ohio.

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uncritical type of photoelectric action—a simple making or breaking of a circuit with the complete interruption of a light beam. For such a purpose, the relays or accessory equipment may merit more consideration than the cell itself.

PERMANENT RESPONSE REQUIRED

The situation is entirely reversed, however, when we come to those applications where permanent response, in keeping with the accuracy of calibrated measurement or control circuits, is the basis for successful use. It is in this latter area that the modern dry-disk photocell has established itself on a firm commercial footing.

Permanence of cell characteristics is nowhere more essential, for example, than in the application which is today more widely known than any other—the illumination meter and its close relative, the photographic exposure meter. Indeed, when all the requirements which a light-sensitive element must satisfy to be used for such a purpose are brought together, we have just about the most rigorous set of conditions likely to be encountered in any photoelectric application, past, present or future:

(1) It must be permanent in calibration.
(2) It must have a spectral response band of sufficient width to include that of the human eye.
(3) It must be compact, and require no external power source.
(4) It must generate sufficient current at low light levels to provide positive operation of measuring instruments or relays.
(5) It must be resistant to injury—or easily capable of being protected therefrom.

The practical success of the dry-disk type photocell in meeting requirements of illumination meters and exposure meters almost confirms in advance its ready applicability to many devices which involve the same general photometric principles.

AUTOMATIC ILLUMINATION CONTROL

Devices for automatic control of illumination, for example, are an obvious extension of the light-meter principle. In one city alone, more than 200 of these units are in operation, controlling the operation of street light circuits with changes in daylight. Airway beacons and protective lights on obstructions along the air lanes have been widely equipped, and governmental approval of this method of control is further confirmation of their dependability. Applied to school rooms and other indoor areas where critical seeing tasks are to be performed, these same illumination control devices assure adequate illumination with the least possible waste.

Now, once the photocell has demonstrated its ability to measure and respond to natural changes in the illumination level, it is only a short step to the type of device in which the source of light directed at the cell is kept constant, and the critical variable is some light-reducing action interposed between the light source and the cell.

SMOKE ALARMS, CONCENTRATION METERS, ETC.

The wide range of commercial equipment functioning on this basis extends all the way from fire alarms to the making of blood counts. In a widely used type of shipboard fire detector, for example, small tubes lead from the individual holds to a cabinet in the control room. A small fan draws air continuously from the holds through these tubes. Should smoke from any one of these points be drawn up the tubes, it will come between a light source and cell, and the resultant decrease in output being generated by the cell will operate a relay and sound an alarm. Units involving essentially the same principle have been applied also to power plant stacks as a guide to boiler operation or smoke elimination.

The detection of critical amounts of undesirable or dangerous gases in mines and other industrial applications is being met in a somewhat similar way. Here, the air to be sampled is drawn into a test chamber in the presence of a reagent which causes a light-interrupting reaction when the undesirable gas is present. Naturally, any substance which can be made to reveal itself by a change in color can be automatically detected in similar fashion, and many such units have been built, both to meet an individual need and for commercial sale.

Perhaps the most critical application of this type is involved in the photelometer developed by Drs. Sheard and Sanford of the Mayo Clinic and Mayo Foundation for use in the rapid determination of hemoglobin in blood samples. After doing this in the laboratory it was found possible to make a test which showed the change in the blood characteristics of a patient directly. This was done by opening a blood vessel, inserting a V-shaped tube, and allowing the blood to flow through the tube while a light penetrated the blood stream and energized a photocell, and a microammeter indicated the current generated. The speed and accuracy of this new method, compared with former methods, brought to medical science a practical and valuable ally.

COLORIMETRIC APPLICATIONS

So far, the photocell applications we have reviewed have been primarily concerned with the intensity of the light reaching the cell. From the very first, however, photocell progress frequently has been called upon for colorimetric discrimination, and for certain control applications in which

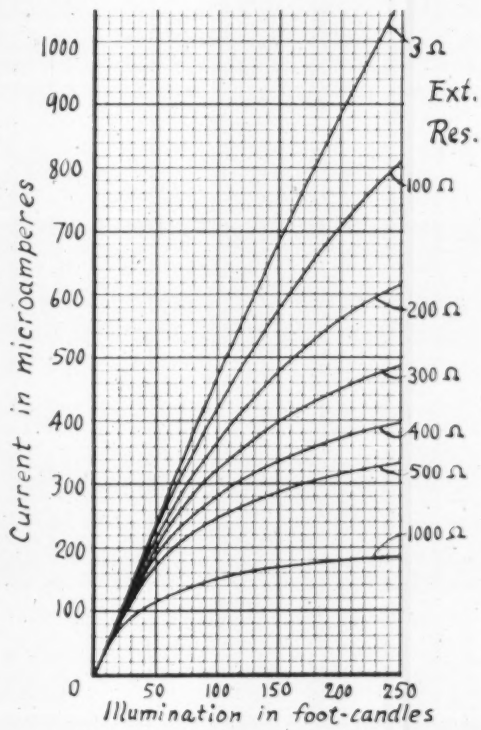

Fig. 4. Characteristic curves of the new "Type 2" high-output Photronic cell.

color changes are the initiating factor. Several techniques have been applied in these devices. In one simple type, a beam of filtered light is directed upon a photocell through a glass absorption chamber in which the sample under test is placed. The relative spectral sensitivity of the dry-disk cell is modified, where necessary, by the use of filters over the light source or over the cell window. It can be made to match the human eye exactly, or it can be made "blind" to every color but red, say.

Colors of paper, textiles, paints, roasted coffee, tobacco and numerous other important articles of commerce are being analyzed and standardized by means of standard or specially designed colorimeters using these dry-disk cells. Because the normal sensitivity of the cell (unfiltered) is considerably higher than that of the human eye at the extreme ends of the visible spectrum, applications involving critical color discrimination in these regions have an accuracy which no purely visual method can approach.

By substitution of a quartz window for the glass window over the cell, the range of spectral response is extended to include the ultraviolet. This has found practical application in determining the therapeutic radiation from ultraviolet lamps in the spectral region from 3,200 to 1,850 A.u. Infrared radiations are also susceptible to evaluation by a properly filtered cell. Pyrometric applications, used either for measuring or controlling furnace temperatures on the basis of the color temperature "seen" by the cell, have achieved an important commercial place. In connection with

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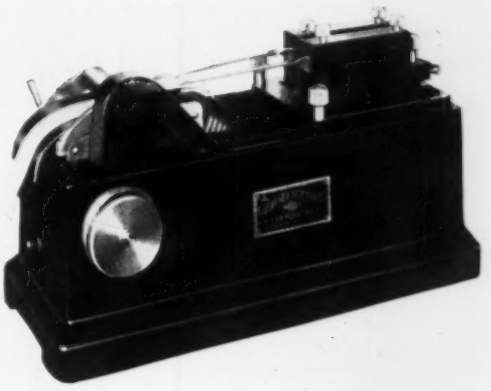

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COUNTERS, ETC.

In contrast to applications such as those for color analysis or temperature control, those which involve the complete cut-off of a light beam as an operating factor call for more emphasis on simplicity, as they are generally in competition with fairly simple mechanical or manual methods for achieving the same results. A ray of light has no inertia and no lag. The cell response is sufficiently rapid to record the passage of a rifle bullet through a beam of light incident upon the cell. It needs no guides or bearings as does a mechanical lever of one sort or another. It will not mar the most delicate fabric nor upset the balance of top-heavy bottles or packages. Light cannot clog or stick. Wher-

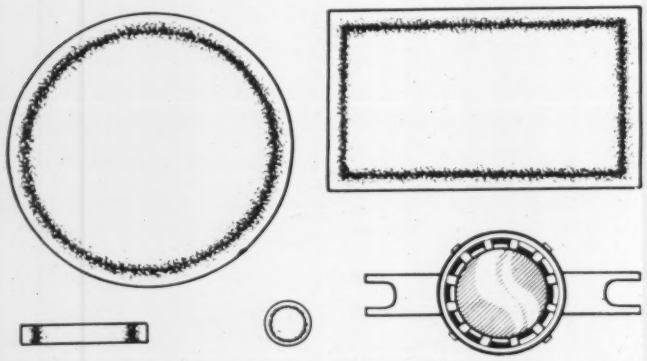

Fig. 5. Various sizes and shapes of cells (actual sizes).

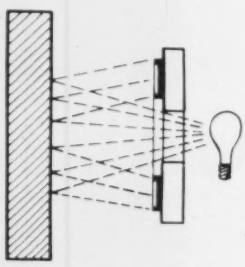

Fig. 6. Open-center cell for reflectometers.

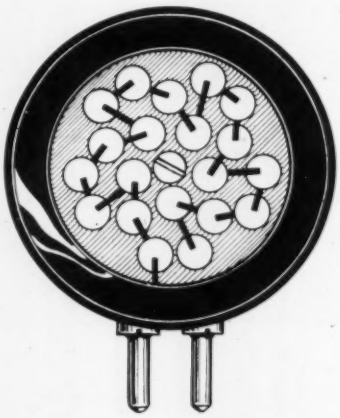

Fig. 7. Assembly of twenty small cells in series.

ever some or all of these factors are important to industrial operations, photoelectric control has come into general usage —specific applications including counting and sorting, control of conveyor speeds, the centering of printed wrappers on packaging machinery, lining-up the fabric in print cloth manufacture, and scores of others.

Another application of the cut-off principle which has expanded greatly in recent years is in automatic weighing and automatic proportioning devices. Generally, movement of the scale beams or pointer in front of a cell window is the actuating method employed. With the proper type of relay equipment, valves, etc., cut-off of filling, emptying, etc., at a desired level can be secured with virtually no lag.

PHOTRONIC CELL IMPROVEMENTS

From the standpoint of expanding the practical usefulness of the dry-disk photocell, it is probably safe to say that, over the past few years, improvements in cell application by means of more sensitive accessory equipment have kept pace with improvements in cell characteristics. In other words, measuring instruments and control units have been specifically designed to take full advantage of the energy generated in the cell, particularly at low light levels. The instrument movement used in the photographic exposure meter is one example; the magnetic contact relay (Sensitrol) is another. Protection of the cell against dampness, vibration and other forms of physical injury have also been of considerable importance in assuring permanence of response and unfailing operation.

There have been definite improvements in fundamental cell characteristics, in the direction of providing increased current output without sacrifice of stability. At one time, certain applications calling for high output were met only at a considerable sacrifice in permanence. Within the last year or so, however, the so-called "Type 2" high-output cell has met the standards necessary for use in permanently calibrated circuits. Output curves of this cell under various levels of illumination (at different levels of external resistance) are shown in Fig. 4.

From time to time over the past decade, modifications in the physical form of the cell have been made to meet special requirements. Cells have been made in square, rectangular and other special shapes (Fig. 5) and with a hole in the center so that a light beam may be passed through in measuring normal reflectivity (Fig. 6). Assembly of cells in banks, connected in parallel, give the increased current output needed for special applications under low illumination levels. One of the first uses of an assembly of this kind was for measuring the brightness level during the 1932 total eclipse of the sun. The voltage generated by the cell is a characteristic unchanged by the size of the cell, so that occasional applications calling for increased voltage can be met by connecting a number of small disks in series (Fig. 7).

Knowledge of the fundamental photoelectric effects involved in cell design and manufacture has now reached a point making possible the creation of cells "tailor-made" to the requirements of the job, where conditions limit the usefulness of the regular types. The entire operation, from the processing of the raw materials to the sensitization of the finished cell, is performed under close technical control in the Weston plant. The materials, skills and experience are all currently available right here in America to move forward into a new decade of progress in which even greater commercial utilization can be expected from the dry-disk photocell.

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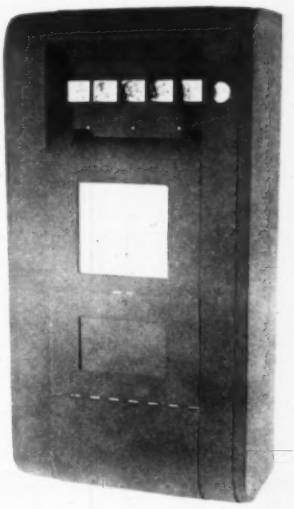

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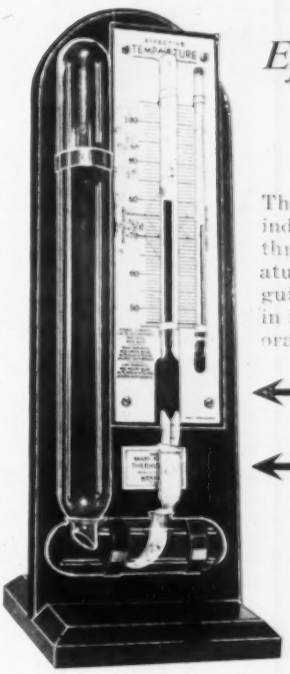

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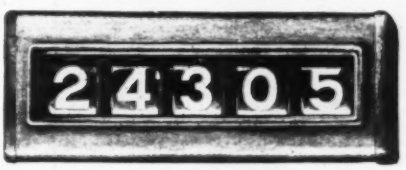

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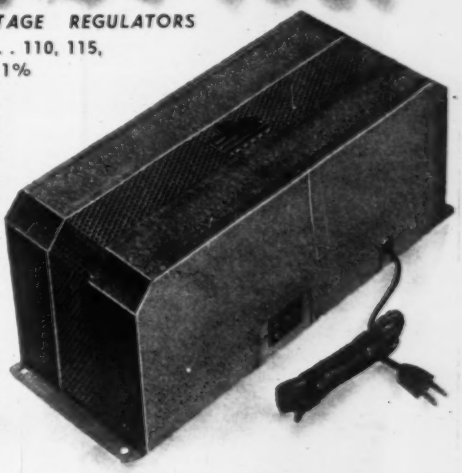

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INSTRUMENTS' BOOK SHELF

Theoretical Physics—Vol. III—Relativity and Quantum Dynamics. By W. Wilson. E. P. Dutton & Co., Inc., New York, 1940. Cloth, 5¾ × 9 inches, x + 276 pages. Price $5.75.

This is the concluding volume of a monumental trilogy which probably will influence the progress of physical sciences for many years to come by reason of the author's penetrating insight, lucidity of expression and originality of presentation. For more than a decade the author has graced the Hildred Carlile Chair of Physics at Bedford College in the University of London. His chief guiding principle in preparing all three volumes has been "to present physical theory as a coherent logical unity." This guiding principl was fairly apparen in the first volume; more obvious in the second volume; and it shines forth in its full glory throughout most of the chapters of this third volume. Again and again Professor Wilson derives some of the important laws in various ways, from radically different starting-points. Again and again he says in effect: "There is another way of expressing the formula . . We may write it . . . and therefore . . . so that . . . but we may substitute . . . so that . . . and we obtain . . . which is identical with . . . " and he gives a result which had been obtained in a previous chapter or in a preceding volume.

The reviewer does not wish to give the impression that Professor Wilson's emphasis on "presenting physical theory as a coherent logical unit" in this particular way detracts from the value of this volume as a text on theoretical physics. This emphasis neither added nor detracted from the value of the two preceding volumes; and it *adds* immensely to the value of *this* concluding volume. In all its fourteen chapters, the seriously-curious reader is delighted to find that the author has anticipated his unformulated questions. The two main subjects of this book, i.e., relatively and quantum dynamics, are seen to be extensions of mechanics, heat, electromagnetism and optics (the chief subjects of Volumes I and II). The thoughtful reader gets a few glimpses of the light shed by the yet-invisible Prime Theory. Only in a modest, indirect way does the author's Preface allude to this achievement:

"Relativity, which occupies the earlier part of the volume, has been introduced in a way which I believe to be new. Einstein's special theory of relativity is developed in what seems to be the most natural way, i.e., by following the suggestions contained in the 4-dimensional character of many sets of equations contained in both of the Volumes I and II, more especially those contained in the Maxwellian field equations as they appear on page 114 of Volume II. Moreover, during the development of the special theory the general theory has been kept in mind, so that the way into it has, I think, been made quite easy.

"A novel feature of the latter part of the volume is the discussion of the remarkable analogy between geometrical optics and Hamiltonian dynamics and the use made of it, by expanding it so that it becomes an analogy between optics (using this term in its widest sense and as understood before the days of the quantum theory) and dynamics, to develop quantum dynamics."

The six years that intervened between the completion of Volume II and of this one witnessed many advances in physics, but one must not conclude that the first two of Professor Wilson's three volumes are almost out-of-date even if this volume is up-to-date. The reason is that during these six years there have been no major discoveries affecting the fundamental thinking of physicists. One reviewer's guess is as good as another's, and our guess is that this trilogy of Wilson's will not become obsolete for a quarter-century or so. To be sure, minor discoveries in limited fields may invalidate a few unimportant demonstations outside the main line, but this *main line* will stand intact: Newton—Carnot—Maxwell—Lorentz—Einstein—Planck.

An example of a need of revision *outside* the main line is found in the section on Debye's theory, where the author states that Born and Karman have taken into account that "solid substances are crystalline . . ." This probably is a slip of the pen. A crystalline substance is one of the several distinct types of solids; there are various ways of classifying crystalline substances; and the Born-Karman equations are of limited applicability; but Professor Wilson made this statement incidentally (in introducing the dominance of electronic energy as the "heat" in solids at temperatures near 0°K.) and it is only in such incidental and trivial details that his work will have to be revised until there occurs the next major revolution in physics. Then only will a real revision become necessary . . . (in 1965?).

As in the case of the preceding volumes, the treatment is austerely mathematical and the author does not compromise with his lofty purpose by stooping to the level of students who are utterly lost without trite and false mechanical analogues. The "average engineer" who has taken college mathematics will get a good deal of effortless enjoyment out of this book; and if he studies the chapters on tensor analysis, wave mechanics and matrix mechanics he will be able to make a few altitude flights, on the wings of Wilson's work, to those lofty regions where he may catch thrilling glimpses of what Whitehead père visioned when he declared that "every branch of physics gives rise to an application of mathematics. A prophecy may be hazarded that in the future these applications will unify themselves into a mathematical theory of a hypothetical substructure of the universe, uniform under all the diverse phenomena."

—M. F. Béhar

Time and Its Reckoning. By R. Barclay Way and Noel D. Green. Chemical Publishing Co., Inc., New York, 1940. Cloth, 5½ × 8¼ inches, viii + 137 pages. Price $3.00.

In spite of the words "and its reckoning" in the title, this little book is entirely nonmethematical. There is not even one equation in it. There is not a single quantitative statement that an elementary-school graduate could not grasp. This is indeed an achievement—almost a *tour de force*—and the authors must have labored for many hours over many brief paragraphs and even sentences which are so easy to read that they seem to have been dashed off without difficulty.

Although this is a non-technical book, it can be recommended as an introduction to the subject of horology for engineers and research men who have never taken this subject and desire to know its rudiments. However, of the ten chapters, five are not strictly on the subject of horology. Chapter VI for example ("Some Unusual Clocks and Watches") deals with curiosities; and Chapter X ("The Nature of Time") is metaphysical, as the authors state in their preface—from which we quote the following:

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This reviewer, thinking of what would interest *Instruments* readers, recommends particularly the following chapters:

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IV. The Pendulum as a Time-keeper.
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The book was written and printed in England, but the examples of movements are none the less useful to American readers.

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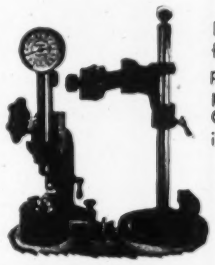

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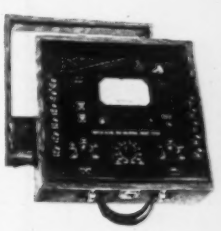

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